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The MONTHLY WEATHER REVIEW is based on data from about 3500 land stations and many ocean reports from vessels taking the international simultaneous observation at Greenwich noon.

Special acknowledgment is made of the data furnished by the kindness of cooperative observers, and by Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt I. S. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Secretary, Meteorological Office, London; H. H. Cousins, Chemist, in charge of the Jamaica Weather Office; Señor Anastasio Alfaro, Director of the National Observatory, San José, Costa Rica; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen College, Havana, Cuba.

As far as practicable the time of the seventy-fifth meridian, which is exactly five hours behind Greenwich time, is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

SALTON SEA AND THE RAINFALL OF THE SOUTHWEST.

By Prof. ALFRED J. HENRY. Dated January 25, 1907.

There is a growing belief in the extreme Southwest, and possibly in other parts of the country, that the creation of Salton Sea is, in large part, responsible for the heavy rains of the last two years, not only in Arizona, but also in the Rocky Mountain States, and thence eastward over the plains. So strong is this belief that some persons have gone so far as to publicly advocate the maintenance of the present Salton Sea, notwithstanding the efforts now being put forth to shut off its supply.

Like other popular fallacies the present one doubtless arose from a careless consideration of the facts in the case, failure to consider whether the supposed cause was capable of producing the observed result, and finally, a misconception of the physical laws under which moisture in the atmosphere is condensed and precipitated as rain.

The facts, so far as they concern the purpose of this article, omitting all general details which are already familiar to the public, are as follows:

As early as October, 1904, there was some seepage water in the depression now known as Salton Sea, but no overflow water. In November, 1904, the Development Company completed a third intake on the Colorado River some miles below the first and second intakes in order to increase the supply of water for irrigation purposes. Soon thereafter a flood wave in the Colorado River scoured out the third intake so that it admitted more water than was needed. The surplus, which at times was very large, naturally sought the lowest part of the depression known as Salton Sink, and in the course of time Salton Sea was formed. It appears, however, that the increase in size of the so-called Salton Sea was gradual, and that it was not until October, 1905, that the total flow of the Colorado River was carried by various channels, mainly the Alamo and New rivers, into Salton Sink.

The rainfall of October, November, and December, 1904, in southern California and Arizona was not out of the ordinary, but beginning in January, 1905, and continuing thruout February, March, and April, an extraordinary amount of rain fell over a belt of country stretching from Florida to southern California, and the region of heavy rainfall also extended into eastern Colorado, eastern Wyoming, western South Dakota, western Nebraska, and western Kansas. With the coming of summer the locus of heavy rains shifted to the States of Nebraska, Kansas, South Dakota, and Oklahoma and Indian Territories. September and October were generally dry months, but in November heavy rains fell in Texas, and thence westward to Arizona. December was dry. In 1906 practically the whole of that great region west of the ninety-fifth meridian received more than the normal rainfall, the regions of greatest excess being central and western Kansas, central and western Nebraska, all of South Dakota, Wyoming, Colorado, Utah, and central and southern California. The excess in Arizona and New Mexico was not strikingly large.

Considering these facts in proper sequence it will be observed, first, that Salton Sea was not formed until *after the heavy rains of January, February, and March, 1905*, so that to ascribe the increased rainfall to Salton Sea would be to place the effect before the cause.

Admitting, for the sake of argument, that a body of water of the dimensions of the present Salton Sea existed before January, 1905, let us examine its probable effect on the rainfall of the Southwest. Its present dimensions are approximately 60 miles long, 8 miles broad, and say 25 feet deep on the average. These are rough estimates, but they will serve the purpose. The cubic contents would therefore be $60 \times 8 \times 0.0047 = 2.2$ cubic miles of water.

The normal annual rainfall of Arizona as determined by Section Director Jesunofsky is 11.75 inches. The rainfall for several years previous to 1905 was as follows:

1899	8.4 inches.	1903	9.9 inches.
1900	8.3 inches.	1904	9.8 inches.
1901	10.6 inches.	1905	26.6 inches.
1902	10.3 inches.		

From this statement it will be seen that the excess for 1905 was 14.85 inches, an amount more than equal to the normal annual rainfall. An inch of rainfall per square mile is equal to 72,516 short tons. As the area of the Territory is 113,956 square miles, the excess in tons for 1905 would be in round numbers $72{,}516 \times 14.85 \times 113{,}956 = 122{,}717{,}500{,}000$ short tons. Converting this amount into cubic miles of water for a comparison of its volume with that of Salton Sea, we have, as before, 1 inch of rainfall on a square mile weighs 72,516 tons. A cubic mile would be this weight $\times 5280 \times 12 = 4{,}594{,}613{,}760$

tons, or assuming that the temperature was somewhat above 39° F., say in round numbers 4,500,000,000 tons. The number of cubic miles of rain that fell in Arizona in excess of the average was, therefore, $\frac{122,717}{4500} = 27$. This quantity, as may be readily seen, is twelve times greater than the total volume of the Salton Sea. In other words, the total volume of the latter would barely suffice to produce one-twelfth of the surplus rain that fell in Arizona, to say nothing of the rainfall in adjoining regions. The total amount of water now in Salton Sea, if uniformly distributed in Arizona, would cover the Territory to the depth of about an inch and a quarter, or the equivalent of one good soaking rain. How then could the evaporation from Salton Sea, even if it amounted to 8 feet per annum, granting that it was all condensed and precipitated to earth, produce the enormous quantity of water that fell in Arizona in 1905?

As pointed out by Mr. Arthur P. Davis in the National Geographic Magazine, January, 1907, the advocates of the idea that Salton Sea has caused an increase in the rainfall of the Southwest seem to have ignored the presence of the Gulf of California, a body of water hundreds of times larger than Salton Sea, and distant from Arizona about the same number of miles. This body of water washes the shores of a region probably as arid as can be found on this continent. It has done so for centuries, yet no progressive changes from arid to humid conditions have been observed.

Mr. Davis has also pointed out that the disaster which caused the formation of Salton Sea has prevented the normal overflow of the lands in the Colorado Valley below Yuma. The areas of land in that region which would have been overflowed under normal conditions are nearer to Arizona and New Mexico, and of greater extent than Salton Sea, so that if evaporation alone causes rainfall, the tendency of the formation of Salton Sea would have been to reduce rather than increase the rainfall of Arizona and New Mexico.

The obvious deduction from the foregoing is that the Salton Sea is not responsible for the phenomenal rainfall of 1905 in Arizona.

THE INFLUENCE OF SMALL BODIES OF WATER ON LOCAL CLIMATE.

It is generally believed that small bodies of water have an appreciable influence on the local climate of contiguous land areas, but it is exceedingly difficult to distinguish between results which may be due to purely local causes and those which may be reasonably due to general causes.

The effect of a small body of water such as the Salton Sea on the climate of the surrounding territory may be recognized in two principal ways, first, in its equalizing effect on the temperature, and second, in the increased amount of water vapor thrown into the air by evaporation, since more water is evaporated from a water surface than from forests or fields. Owing to the fact that a water surface warms up much more slowly than a land surface and retains its heat much longer, the water surface will, in general, be warmer at night than the land, and cooler in the daytime. Thus there will be a tendency toward lower maximum temperatures and higher minimum temperatures in a narrow zone immediately surrounding the lake, but especially on the leeward shore.

The distinguishing characteristics of the climate of the Salton Sea region are those of the desert, viz, great heat and dryness. The annual mean temperature is about 77°; winter, 57°; spring 75°; summer, 97°, and autumn, 79° F. The maximum temperatures of the summer months range from 115° to 130° F., and the minimum temperatures of winter from 20° to 25° F. The annual precipitation is about 2.50 inches, most of which occurs in the cold months. The months of April, May, and June are practically rainless, but occasional showers fall in July, August, and September in about 30 per cent of the years. December and February are the months of greatest rain. In the winter snow may fall, but it rarely lies on the ground more than twenty-four hours; the average number of days in a year with 0.01 inch or more of precipitation is four. The winds of the Colorado Desert are mostly northwesterly in winter, and southeasterly to easterly in summer. In the cold season they flow through San Gorgonio Pass in the northwestern part of Riverside County, elevation about 2500 feet, as westerly winds, but are deflected somewhat toward the southeast by the San Bernardino Range which skirts the eastern and northern limits of the desert. Being descending winds and dry they are not favorable to precipitation. The cold winds are generally from north and east, while rain winds are from east and south. In summer the winds are not so stable as regards direction as in winter. While they are largely from the east and south there is at times a marked westerly component. No record of the diurnal change in the wind for the Salton Sea region is available.

At Yuma, Ariz., about ninety miles to the southeast, the winds in winter shift from northerly or northwesterly in the early hours of the morning, to northeast in the forenoon, and return to the same directions at night. During the latter part of April the northerly winds begin to give way to south and west winds; as the warm season progresses the northerly winds of winter shift to a southerly quarter. There is, however, a considerable easterly component at all seasons.

In the absence of instrumental records of wind velocity, little is definitely known of the force of the wind in the Colorado Desert. At Yuma, Ariz., high winds are infrequent, yet there is considerable motion in the air during the afternoon and evening hours. Such motion, however, is clearly discontinuous, and not calculated to transport air bodily out of the desert region, or to cause the importation of air of different density and moisture from adjoining regions. The particles of air that are set in motion by the winds of the daytime do not move continuously in the original direction, but are carried hither and thither by the light variable airs of the nighttime, and in some cases even in a direction contrary to that in which they traveled in the daytime. The annual hourly velocity of the wind at Yuma is nearly seven miles per hour, 3.1 meters per second, and the range is from an average velocity of three or four miles in the early morning hours to eight or ten miles in the afternoon. At Furnace Creek in Death Valley, an independent north-south basin, an average wind velocity of 9.9 miles per hour, 4.5 meters per second, was recorded from May to September, inclusive, but here the force of the wind is doubtless augmented by the local topography, and the results are not of general application. In general, it seems reasonable to assume that while there is more or less interchange of air between different portions of the desert, there is no permanent flow of the surface air in any direction except in winter, when the Plateau region is occupied by an area of high pressure. Then the winds blow from the north with much steadiness, so long as the Plateau high exists.

The moisture contents of the winds, especially at Yuma, are surprisingly constant. The north wind, since it descends from somewhat higher levels, is, in general, a dry wind, yet in the winter season the greatest relative humidity of the month may be experienced with a north wind. The moisture contents of the different winds for a winter month (February) and a summer month (August) are shown in the following table:

Vapor tension at Yuma, Ariz.

(An average of ten years.)

Direction.	February.	August.	Direction.	February.	August.
	Inches.	*Inches.*		*Inches.*	*Inches.*
North	0.16	0.57	South	0.21	0.60
Northeast	0.20	0.59	Southwest	0.22	0.55
East	0.20	0.67	West	0.21	0.56
Southeast	0.25	0.67	Northwest	0.20	0.54

The amount of aqueous vapor actually present in the air may be exprest either by the expansive force or pressure that it exerts or by its weight in grains in a cubic foot of space. In the above example it is stated in terms of its expansive force, or barometric pressure, in inches of mercury. Whether exprest in terms of weight or pressure, the amount of vapor actually present is sometimes called the absolute humidity. It is very important to distinguish between the absolute humidity and the relative humidity, sometimes referred to merely as the humidity. The relative humidity is the ratio of the amount of vapor actually present to that which might be present at the existing temperature if fully saturated: Example from Death Valley, June, 1891, temperature of dry bulb, 108° F., wet bulb, 68° F., whence is obtained from hygrometric tables: dew-point, 39° F., relative humidity, 10 per cent. A relative humidity of 10 per cent or less is not at all infrequent in desert regions. The observation quoted means, first, that in order to condense any of the moisture present into dew or rain the temperature would have to fall 69° (from 108° to 39° F.), or the amount of moisture then in the air would have to be increased ten fold. This point can not be emphasized too strongly. At the temperatures which exist in the Colorado Desert, and under the general conditions of aridity which prevail, the atmosphere takes up vapor as a sponge absorbs water. It should be remembered, moreover, that the capacity of the air for vapor is vastly greater at high than at low temperatures; the problem in the Southwest, therefore, so far as the production of rain is concerned, is not essentially one of increasing the vapor contents of the air but rather of diminishing the temperature to the point at which condensation takes place. There is sufficient moisture in the air to produce abundant precipitation if means of cooling it were at hand. The absolute humidity at Yuma is slightly greater than that of St. Louis, and only a little less than that of Vicksburg, both of which points have, in general, an abundance of rain and a so-called moist atmosphere.

The amount of vapor taken into the air over Salton Sea must be considerable in the course of a year, but to adduce definite and satisfactory proof that it has increased the rainfall is a very difficult problem. That it has increased the relative humidity in a slight measure, is undoubtedly true. Aqueous vapor in the absence of a strong wind circulation is diffused very slowly thruout the atmosphere. It is, therefore, improbable that any considerable portion of the local supply of vapor ever passes beyond the immediate confines of the desert. The writer knows of but one case where there is a reasonable presumption that the local evaporation has increased the rainfall, and the increase in this case amounts to but two or three inches annually over the immediate area whence the evaporation proceeds.

CHANGES OF LATITUDE AND CLIMATE.

It is well known that shortly after Mr. Chandler's convincing demonstration that the axis of rotation of the earth is changing its position within the earth in an irregular way not previously recognized, many astronomers suggested various explanations of the phenomenon in the search after the forces that brought it about. The memoir that seems to have had the greatest acceptance was that of Prof. Simon Newcomb, appearing in 1892, and showing in the first place that a periodic term of 306 days proper to a strictly rigid earth, as deduced by Euler and called the Eulerian period, would be increased if there were any elastic yielding of the earth under the great stresses to which it is subjected. Hough (1895) showed that an elastic steel globe would have a "free" period of 428 days in its axis of rotation as one of the terms in the nutation due to the action of the sun and moon on our globe. Newcomb also showed that a displacement of material on the earth's surface, such as the annual transportation of rain and snow between the poles and the equator, and possibly other meteorological phenomena, recurring year after year, would maintain such a variable annual disturbance of the regular 428-day term as to produce the change in latitude discovered by Chandler, since these phenomena produce a variable moment of inertia and are not symmetrical with regard to the earth's axis. The influences of changes of load have been most exhaustively studied by Prof. R. S. Woodward.

In a recent memoir by Prof. J. Larmor and Maj. F. Hills, published in the Monthly Notices of the British Royal Astronomical Society,[1] the authors have analyzed the movements of the North Pole, as most exactly determined since 1900 by Albrecht, and less exactly before that time. They have computed by graphical process from a map showing the path of the North Pole day by day, another map showing the departure from the 428-day period, thence the hodograph, and thence the torque that must be acting in order to produce that motion of the pole, whence we may infer something as to the displacements of atmospheric material, oceanic sediments, and continental material that must be taking place in order to produce this torque. By considering individual meridians the locations of the changes in the torques in the direction of the equator and of the meridians, respectively, can be determined approximately. If such changes are mainly due to displacements of surface material by any action of the atmosphere or solar heat they should show seasonal recurrences. Those which are not seasonal may prove to be due to subpermanent changes of masses of water or air as shown by changes in the level of the ocean or in the pressure of the atmosphere. Larmor and Hills show that a surface depression of one foot over a square mile of land, in latitude 45°, extending downward and diminishing to zero at a depth of 30 miles, that is to say, an average displacement of one foot down to 15 miles, would displace the polar axis thru a fraction of a second of arc represented by 3×10^{-13}. Sir G. Darwin showed that one per cent of the area of Africa moving ten feet vertically would alter the polar axis of a perfectly rigid globe by 0.2 seconds of arc. This direct effect upon the motion of the pole is so slight that an ordinary earthquake would have no influence, but observation seems to show that, within several years past, sharp curvatures in the movement of the pole appear to be, on the whole, concomitant with earthquakes. Possibly, therefore, earthquakes are promoted by those changes of the load carried by the earth that are the main cause of the irregular motion of the pole, so that the connection between earthquakes and change of latitude is a secondary one. Now a change of load that could cause an earthquake must, to a great extent, be due to transfer of ocean water, melting of polar ice, monsoonal flooding of large regions, like India, the deposition of mud in deltas, and other periodical matters that belong to meteorology. In fact the mere motion of ocean currents from the polar region, where water has but little angular momentum, to the middle latitudes where it has a great moment of inertia, must have an appreciable influence. The authors figure that if a mass of water representing a layer one foot deep over a region 4000 miles square were to move from the pole to latitude 45° it would displace the pole of rotation in the earth by something like two seconds of arc.

Of course any such movement is ordinarily counterbalanced by an equivalent circulation in the opposite direction; but frequently cases occur in which the equilibrium is not restored for six months or a year, as for instance in the case of an antarctic earthquake when 1000 square miles of ice floe is suddenly dislodged and floats northward, thus diminishing the moment of inertia of that continent until an equivalent amount of glacial snow and ice can again accumulate. A periodic change of this sort always occurs when the southeast trade breaks

[1] Presented at the meeting of the society in London, Nov. 9, 1906.

across the Indian Ocean and becomes the southwest monsoon, driving a great mass of surface water before it from equatorial into northern latitudes, while at the same time depositing two or three feet of rain water along the Asiatic coasts.

A study by Larmor and Hills of the curve of torque seems to them to point preponderantly toward the Pacific Ocean as the source of the disturbances, as tho there were a simultaneous accumulation or diminution of load in the neighborhood of the meridians that are perpendicular to the center of that ocean, namely 90° east and west of Greenwich. The procedure adopted in their memoir has been to eliminate the uniform precession and nutation of the ellipsoid of revolution in order to bring out prominently the irregular shifts due to the torques produced by the irregular redistribution of material. Altho they do not distinctly allude to the fact, yet it may be worth mentioning that the meridians perpendicular to the center of the Pacific correspond to those on which are located the North American and especially the Asiatic regions of winter high pressure and summer low pressure, and it is worth inquiring whether the annual variation in distribution of rain, snow, wind, or pressure can possibly have produced the torques of whose causes we are in search.

While the above-mentioned investigation has great interest in its relation to the current state of the globe it is of still greater interest in connection with the question of the variation of climate in past geological ages. Among the numerous hypotheses that have been put forward to explain the occurrence of glacial epochs a change in latitude has often been urged; but our authors show that this is mechanically impossible without, indeed, such an upturning of the earth's surface as is thoroly inconsistent with the horizontal stratification that has been going on since Archean times. The amplitude of the oscillations of the earth's pole will always be kept small by the internal friction or viscosity of the soft interior, so that the axis of rotation will always be near the principal axis of inertia, and can never wander farther from its original position than the latter does.

I have never felt certain that we need to assume great heat in the interior of the earth. The small amount of heat conducted outward annually thru the outer crust may be supplied, not by conduction from a molten center, but by the slow chemical, physical, and crystallizing processes going on within the crust, and especially by the mechanical crushing, sliding, and faulting that accompany the tidal strains produced by the attraction of the sun and moon combined with the diurnal rotation of the earth.[2] By these tidal strains the gravitational work—at least a small fraction of it—is converted into internal heat thus supplying that which is conducted both outward and inward, so that the interior never can cool to absolute zero. If the daily or annual conduction outward is just equivalent to the daily or annual development of heat by the crushing due to tidal strain, then we can reckon the corresponding amount of work done or the force that does it.

The theory of isostasy advocates the idea that continents are the tops of intrinsically lighter masses floating on a liquid or viscous material. But such canyons as those of the Congo and Hudson, as well as the stratified geological formations, show that continents have risen and fallen relatively to ocean levels so frequently and so much that they are not continents by reason of a small density, but for other reasons that can be reduced to shrinkage and tidal strain, as indeed was expounded by me in 1880.

When the sun and moon are simultaneously nearest the earth and in the same geocentric declination and right ascension they produce the maximum interior tidal strain; this was also true in past ages. The strain is greatest when the solar and lunar declinations have their maximum values; i. e., 23° and 28°, respectively; and then the two halves of the earth's crust will buckle and slide over each other at points along a line of weakness most nearly coinciding with the great circle that is perpendicular to the line joining the earth and sun, and therefore tangent to the Arctic and Antarctic circles. This process will be repeated with every conjunction or opposition, and most intensely with every perigee of moon or sun, so that great faults must develop, especially along a system of great circles tangent to the Arctic and Antarctic circles. Thus the earliest granitic shell of the globe was broken up into the systems of faults or bends that define the general outlines of our continents and mountain ranges. The greatest fault is that which incloses the Pacific Ocean; the changes which have occurred in the floor of this ocean have determined the general level of the other oceans, while the continental half of the globe has preserved its general elevation above the oceanic. The depressed half of the crust became so and has remained so by virtue of the crushing due to early tidal strains, and isostasy has had only a minor influence on the relative altitudes.

The researches of geologists have shown that there have been several glacial epochs, the latest addition to the subject being an article by Prof. William M. Davis,[3] where he has shown that there is remarkably clear evidence of glaciation during Permian times, and that, too, of a general continental type, over a large area in the interior of Africa just south of the Torrid Zone, due to the flow of ice from the northward, namely, from a region nearer the equator. Professor Davis thinks that this occurred at a time when that continent had about the same altitude and winds that now prevail, and adds that no conceivable arrangement of continents and ocean currents could have produced an abundant snowfall in latitude 25° south so long as the general temperature of the atmosphere preserved its present value.

We think it must be allowed that glaciations have taken place in various parts of the world during very different geological epochs, and that the conditions which made these local glaciers possible were themselves local, and were not general changes of latitude or solar radiation. We attach most importance to actions that we know have been going on as recorded geologically and historically—e. g., the simple rising and falling of continents, and the changes in the distribution of land and water—and we must pursue an exhaustive study of the possibilities in this line before we feel driven to try hypotheses that can not be reconciled with what we know of the simpler ordinary methods of nature. It is true that a variation in solar radiation is made plausible by considering the variations in brightness of the variable stars, but we shall not need to appeal to that hypothesis until we are convinced that the earth and atmosphere do not possess within themselves the possibility of producing alternate glacial epochs, dry epochs, and moist epochs.

We need not inquire whether orographic changes are due to earthquakes, or loading, or secular cooling and shrinkage of the nucleus; it suffices to recognize that they have always been going on. We are especially imprest by facts pointing to the conclusion that there have been temporary continuous connections between North America and Europe where the Atlantic now rests, and temporary islands, if not whole continents, in the Pacific, which are now represented by small islands and submerged banks. The great gorges of the Hudson and the Congo rivers extend many miles off the American and African coasts, being recognizable at depths of five thousand feet, and these deep canyons show that in some former time those rivers flowed thru dry land, so that the Atlantic was then far smaller and shallower than at present. The mountain ranges, with their earthquake centers,

[2] See Bull. Phil. Soc., Washington, April 13, 1889, vol. XI, pp. 533-536.

[3] Bulletin of the Geological Society of America, vol. 17, 1906, pp. 377-450.

extending from Patagonia to Alaska and from Kamchatka far down along the Pacific coast of Asia, have long been recognized as showing that we have here a part of a great circle around the Pacific representing a belt that is unable to withstand the great strain produced by the tidal action of the sun and moon. The strata of this belt have, therefore, for a long time been gradually crumpling, while the bed of the Pacific has been alternately rising and falling as it rested on the viscous interior of our globe. These oscillations of the Pacific Ocean must have affected the level of the Atlantic. They could change the axis of rotation of the globe only a very few degrees, but affect local climates directly, causing great oscillations in altitude, temperature, and moisture, with only small changes in the general circulation of the atmosphere. The conditions that now produce glaciation in New Zealand, Greenland, Alaska, Switzerland, and Iceland appear to have once prevailed in the Himalayas, the North American Lake region, central Africa, and Scandinavia during the many changes that have been taking place in the orography of the earth's surface. The fundamental condition producing glaciation is simply the ratio between the snowfall of the cold season of the year and the heat, wind, evaporation, and rainfall of the warm season. If the latter agencies are sufficient to melt the winter's snow, then no glacier occurs. As illustrative of this point, it may be well for some one to construct maps of the globe analogous to that which was prepared by me for a lecture in Baltimore in 1898, showing the average total snowfall during the winter seasons of 1884–1895, divided by the average total rainfall of the year. Of course one must take into account the temperature of the rain water and the evaporation from a dry snow surface, as well as the melting of the snow in the sunshine. Our map therefore gives only the crude elements of the problem, but practically the coefficients must be determined meteorologically, by studying the actual records of snow on ground in regions where glaciers now occur.

As concerns the changes of climate in Asia Mr. Ellsworth Huntington, who has been studying in person the physiography of that continent, has discovered what he believes to be conclusive evidence of great changes in the direction of dessication during the last two thousand years. He has brought together conclusive data showing the drying up of rivers and lakes and the retreat of their shores to distances of fifty or a hundred miles. The great caravan routes from China westward have also been changed from time to time owing to the necessity of following the water routes. The area of dessication extends from the Caspian Sea eastward for over twenty-five hundred miles. Mr. Huntington, in fact, seems to maintain that there have been alterations of dry and wet centuries, three such alternations since the year 800, with a long period of abundant rain previous to that. Without discussing his definite epochs we may in general conclude that in the present state of the globe and the atmosphere, and without any change in latitude or altitude, moisture or sunshine, it is perfectly possible for such combinations of winds to occur as to give us in one century conditions favorable for rain, snow, and glaciers, but in another distant century drought, sand, and desert. These alternations depend essentially upon extreme variations in what is called the general circulation of the atmosphere; they are perturbations produced solely by its own internal mechanism. We are familiar with such alternations every six, eight, or ten years in most countries. Brückner has submitted arguments in favor of changes at irregular intervals, averaging thirty-five years, in Europe, while Russell maintains a periodicity of nineteen years in Australia. But the motions of the atmosphere are too irregular to be properly styled periodic; a combination that will occasionally recur so as to give a drought in the United States may do so at very irregular intervals, and no matter whether the average interval is seven, nine, or thirty-five years, it should not be spoken of as periodic. The main point for us to remember is that where now we have droughts once there was abundant rain; where now we have arable land once there were glaciers; and these climatic changes are recurring without any notable change in surrounding conditions. They are the result of the innumerable combinations that may arise, some favorable and some unfavorable; and they will be exactly explained when we fully understand the mechanics of the atmosphere as it now is.—*C. A.*

TORNADOES OF JUNE 6, 1906, IN MINNESOTA AND WISCONSIN.

Referring to page 274 of the Monthly Weather Review for June, 1906, the Editor has received a report written by the late Mr. T. S. Outram, in which he gives some account of the tornadoes which occurred on June 6, 1906. The following brief extracts are sufficient to locate these tornadoes, but many details are given in the manuscript:

> Late in the afternoon of June 6 tornado conditions were evident at many places in eastern and southeastern Minnesota and western Wisconsin, with actual tornadoes occurring in Houston and Chisago counties, Minn., and La Crosse, Monroe, and Vernon counties, Wis.
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> The Chisago tornado evidently developed between Forest Lake and Wyoming, and moved nearly northward some 35 miles to near Harris. The width of the track of greatest destruction varied from 50 feet to about a quarter of a mile.
>
> The effects of the Houston tornado[1] were felt over a wide area, but the storm was most severe between Freeburg and Reno, a distance of about six miles. From Reno the storm seems to have past over the Mississippi River to near Stoddard, Wis., but from Stoddard to Leon, a distance of about fifteen miles, the great force of the tornado was again exerted.
>
> In both these storms the funnel-shaped cloud was present; it was very black, showed a violent whirl in which there was much débris, and toward which the clouds seemed to rush from all directions; the lower end of the funnel whipt about, destroying everything it came in contact with. The wreckage of the buildings and timber seemed to be thrown in all directions, but a few persons thought they noticed that the whirl of the storm was in a direction opposite to that of the hands of a watch. There were heavy rains after the passage of both tornadoes, and in places there were very large hailstones. The noises are said to have been very distinct, resembling the rumbling or roar of a long train of cars.
>
> The characteristic freaks or strange happenings so common in tornadoes were present in these storms also, and a few may be mentioned. A kitchen cupboard, filled with china, standing in a house which was completely torn to pieces, was carried four rods and set down so gently that not a piece of the china was broken. When the storm struck the Inglett place Mr. Inglett, sr., was sitting in the kitchen with a child on his lap; the house was completely demolished, even to the carrying away of nearly all the floor but that on which the man was still sitting uninjured after the storm past. Articles of furniture were carried $4\frac{1}{2}$ miles from their starting point. The rung of a chair was driven thru a large tree, so that its ends projected from each side.

MR. T. S. OUTRAM.

Mr. Thomas S. Outram, in charge of the Minnesota Section of the Climatological Service of the Weather Bureau, died at his post of duty, in Minneapolis, Minn., December 5, 1906.

Mr. Outram was born at Elmira, N. Y., May 26, 1856. His education in public and private schools at Easton, Md., was supplemented by an attendance of eighteen months at Cornell University. He entered the weather service of the Government (Signal Corps) in March, 1879. After serving for five years he severed his connection with the service, but reentered on September 30, 1891, and continued therewith until his death.

Always a capable, energetic, and conscientious public servant, Mr. Outram continued to discharge his duties with accustomed fidelity and exceptional courage long after his physical condition clearly foreshadowed his death. By his demise the Bureau has lost a valuable official, whose integrity and earnestness of purpose justly gave him an enviable standing in the community that he served. His pleasing personality greatly endeared him to his fellow workers and his death will be sincerely mourned.—*J. B.*

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[1] This "Houston tornado" is evidently the storm described by Mr. G. A. Oberholzer in the June Review.—Editor.

STUDIES ON THE THERMODYNAMICS OF THE ATMOSPHERE.

By Prof. FRANK H. BIGELOW.

V.—THE HORIZONTAL CONVECTION IN CYCLONES AND ANTICYCLONES.[1]

SOME OF THE DIFFICULTIES IN THIS PROBLEM.

If one wishes to follow the exact process occurring in the natural circulation of the atmosphere, then the next step in the orderly development of the analysis of the problem of the structure of cyclones and anticyclones is exceedingly difficult, and some time must elapse before meteorologists will be able to complete the solution in a rigorous manner. This may be explained by resuming our study of the interchange of energy in the nonadiabatic circulation between high and low areas.[2] Equations (44) and (52), so far as they relate to the circulation in a horizontal plane $x\,y$, in the integrated form give the following:

$$C_p\,n_0\,(T-T_0) + C_p\,T_0 \log T_0\,(n-n_0) = (Q-Q_0) - \tfrac{1}{2}\,(q^2-q_0^2).$$

Since there is to be an interchange of energy between the cold area, whose center will be marked C, and the warm area whose center is W, the following notation will be employed:

$$\left.\begin{array}{l} n_0\text{, the gradient ratio}^3 \\ T_0\text{, the temperature} \\ q_0\text{, the vector velocity} \\ Q_0\text{, the heat energy} \end{array}\right\}\ \text{in the cold area, } C.$$

$$\left.\begin{array}{l} n\text{, the gradient ratio}^3 \\ T\text{, the temperature} \\ q\text{, the vector velocity} \\ Q\text{, the heat energy} \end{array}\right\}\ \text{in the warm area, } W.$$

The C and W areas lie between the centers of high and low pressure, marked H and L, respectively, in the order from west to east, as follows:

H (high); C (cold); L (low); W (warm);

as illustrated in the diagrams of papers No. I, II, III, and IV of this series. (MONTHLY WEATHER REVIEW, 1906, January, February, March, and June, respectively.)

(A) One problem is to show the relations between the thermodynamic centers C and W, and the hydrodynamic centers H and L in the moving atmosphere. It will not be proper to make model circulations by erecting chambers around given masses, and then removing certain internal partitions. This process really evades the entire problem to be solved, and substitutes some ideal or experimental system in place of that occurring in the atmosphere.

(B) Another problem is concerned with the gradient factors (n_0 and n) and the temperatures (T_0 and T), and may be stated in the following form. Since the gradients of temperature are changing from point to point in the vertical and in the horizontal directions in a very complex fashion, it seems impracticable to assign temperature functions in advance of the actual observations, and therefore analytic formulas of sufficient flexibility to express the entire existing conditions are impossible. If a simple function of the temperature is adopted, it is certain that this functon will not be applicable to the cyclonic structure taken as a whole, and hence it is very hard to derive the pressures from the temperatures by the simple quasi-adiabatic formulas.

(C) Furthermore, the most troublesome problem of all, in the present state of meteorology, is to show what is the relation between the velocity terms (q_0 and q) and the heat terms (Q_0 and Q). The cyclonic circulation constitutes an effort to bring back to equilibrium the energy-difference represented in the cold and warm areas, and this is done by setting up an extensive series of internal vortices, graduated in size from the large storm areas, down thru tornadoes or secondaries to the minute whirls that are not accessible to any instrumental records. In this interchange of heat between the warm and cold masses, a portion of the energy is absorbed in maintaining the velocity of the masses of air, a second portion goes into radiation, and a third part into equalizing the temperatures. The velocity of the wind in a cyclone does not measure the true velocities (q_0 and q), since the latter include the total internal circulation as well as the flow of the main stream; but there seems to be no way to separate these parts from one another. In a word the total energy is given by the terms

$$C_p\,n_0\,(T-T_0) + C_p\,T_0 \log T_0\,(n-n_0),$$

but I can as yet discover no method of distributing the respective portions of this total among the equivalent terms,

$$(Q-Q_0) - \tfrac{1}{2}\,(q^2-q_0^2) + \text{radiation.}$$

Until all these difficulties have been overcome it will be possible to make only tentative and incomplete discussions of the great problem involved in analytic meteorology.

(D) Finally, the general question as to the reason why the observed gradients of temperature differ from the adiabatic gradient is closely bound up with the distribution of the available energy between the q and Q terms. If a mass of air is moved from one level to another, as from 5000 meters to 4000 meters, in an adiabatic atmosphere, the pressure and the temperature change according to the adiabatic law; in a nonadiabatic atmosphere, the change of temperature does not correspond with the pressure, but a divergence exists depending on the proportion represented by the difference of the ratios $n - n_0$. If in a nonadiabatic atmosphere there is vertical displacement of an air mass, the interchange of energy is partly as heat and partly as velocity, and at the moment a mass moving adiabatically in the midst of a nonadiabatic mass arrives at such a displacement, $z - z_0$, as to be appreciable in respect to $n - n_0$, there is set up a small local interchange of energy between these masses in the form of a minor gyration of some sort. There is thus a continual tendency to balance these two expenditures of energy, the one against the other, in the most economical way, and the resultant temperature and circulation represents the outcome of this physical process. (See fig. 19.)

If instead of one rising current of warm air, $A\,C$, which becomes overcooled, and one current of cold air, $E\,W$, which becomes overheated by adiabatic expansion and contraction with the change of level, there are several such rising and falling masses in a series stretching from west to east, the interchange of heat becomes more complicated. Thus the cold mass C will be found between two masses of warm air W, and the warm mass between two cold masses on the same horizontal level. In this case each warm mass W will divide and seek $C\,C$ on either side of it; the cold mass will also divide and seek $W\,W$ on either side. Since these small horizontal currents can not flow together from opposite directions to the center because a congestion of mass would occur, the motion is transformed into an inflowing helix with vertical component upward for a low pressure center L, and a counterflowing helix with downward vertical component with a high pressure H at the center of the vortex. This process is the cause of the minor whirls in the atmosphere, and contributes something to the formation of cyclones and anticyclones. In the latter case the warm and cold masses are not produced by vertical adiabatic changes, but by transportation of horizontal currents from great distances. The same tendency to divide the warm mass in the northern quadrants between the low and high pressure centers and to curl the cold mass into two branches in the southern quadrants of the high and low pressure areas, has been already found in the observations of the stream lines and the distribution of the temperatures. The tendency to divide and

[1] This paper logically follows No. IV, in the Review for June, 1906, but its publication has been delayed.—EDITOR.

[2] See Monthly Weather Review, March, 1906, page 114.

[3] See Monthly Weather Review, March, 1906, page 113.

curl about the respective branches is common to all mixing masses of different temperatures.

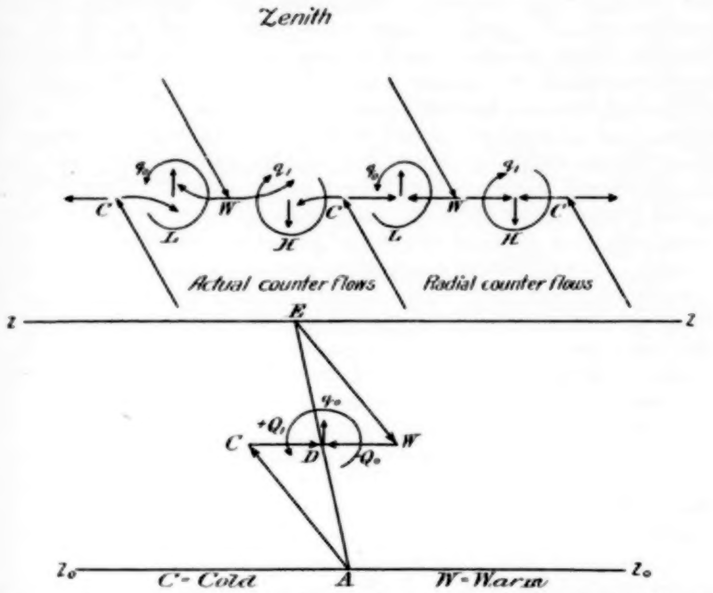

FIG. 19.—Scheme of the transformation of adiabatic gradients into observed temperature gradients thru the heat terms $(Q - Q_0)$ and velocity terms $\left[(q^2 - q_0^2)\right]$.

AE = Observed nonadiabatic gradient.
AC = Adiabatic gradient for warm rising air.
EW = Adiabatic gradient for cold descending air.
CD = Quantity of heat $+ Q_1$ to be added to restore the equilibrium at the height $z - z_0$.
WD = Quantity of heat $- Q_0$ to be lost in restoring the equilibrium.
At the level CDW other amounts of heat, $+\Delta Q_1, -\Delta Q_0$, are expended in setting up a velocity q_0 which is converted into a vortex with a vertical component.

If we find an adiabatic rate of temperature fall in the Tropics such as 10.0° C. per 1000 meters, but one of 5.0° C. in the temperate zones, and of only 2.0° C. in the polar zones, then this distribution between the Tropics and the polar zones is maintained by circulation and heat interchange. The streams of warm air in the lower strata, 0 to 3000 meters, and in the upper strata, 10,000 to 14,000 meters, on moving from the Tropics to cooler latitudes, gradually lose heat by expending the energy thru a series of minor and major gyrations which are set up. These streams near the surface tend by their rising to higher levels, as they approach the polar zones, to stratify the warmer air higher up in proportion to their departure from the Tropics, and thus to lessen the temperature fall from the surface; likewise, above the 10,000-meter level the same phenomenon occurs. Similarly, the cold polar currents flowing toward the equator tend to sink to lower levels, and this diminishes the temperature gradient in the middle latitudes. These two systems of currents can not traverse the space between the Tropics and the polar zones without encountering one another, and interacting upon each other, in the cyclones and anticyclones, and the general effect of the entire process is to maintain a gradient of temperature which differs from the adiabatic rate. The divergence between the actual and the adiabatic rate is very different from place to place, as shown by the observations. There is an incessant turmoil of adjustment at all levels, and in all latitudes, whose outcome is the wind, clouds, rain, and temperature actually prevailing. As above stated, it seems to be impossible to treat this physical complex as an analytic unit in the present state of meteorology, and hence I shall confine my discussion to a series of more or less detached studies, which yet tend to elucidate the general problem.

THE HORIZONTAL CIRCULATION.

In Tables 29 and 30,[4] under the columns $z - z_0$, are given the vertical distances thru which the cold masses must fall and the warm masses rise, in order to attain an equilibrium on their respective levels. Thus, for the maximum cold masses in the east quadrant of the high area and the west quadrant of the low area, and for the maximum warm masses in the west quadrant of the high area and the east quadrant of the low area, we find the displacements in the winter, respectively, as follows:

TABLE 41.—*Vertical displacement, $z - z_0$, from equilibrium.*

Height in meters.	High east.	Low west.	Mean.	High west.	Low east.	Mean.
10000	+325	+454	+390	− 325	−487	−406
9000......	+366	+440	+403	− 352	−440	−396
8000......	+425	+467	+446	− 425	−382	−404
7000......	+498	+498	+498	− 569	−356	−463
6000	+592	+563	+578	− 740	−326	−533
5000......	+748	+650	+699	− 926	−325	−626
4000	+793	+646	+720	−1033	−333	−683
3000......	+854	+726	+790	−1024	−299	−662
2000......	+984	+777	+881	−1036	−311	−674
1000......	+836	+593	+715	− 890	−351	−621
0......	+511	+414	+463	− 487	−268	−378

The sign (+) means that the mass is too high by the given number of meters for thermodynamic equilibrium, and the sign (−) that the mass is too low. The cold masses can fall thru $z - z_0$ meters and the warm masses can rise thru $z - z_0$ meters on their respective levels, under the given conditions.

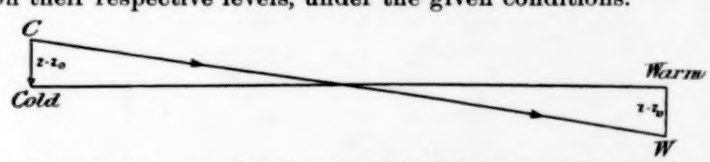

FIG. 20.—The conversion of vertical falls into horizontal circulation.

Thus at the 4000-meter level the cold mass can fall about 720 meters and the warm mass can rise 683 meters to bring about thermal equilibrium, *when there is no horizontal circulation.* If the cold air could sink to the level of the warm mass thermally, it would have a potential fall of 1403 meters, supposing this warm mass to remain unchanged in position and energy. The tendency is then for the cold mass in seeking the *lowest thermal level* not to fall vertically, but in the main to move almost horizontally down a gradient defined by CW. Assuming that the distance between the maxima C and W averages as in the ordinary cyclone about 1000 kilometers, or 1,000,000 meters we have a possible gradient,

$$G = \tan^{-1}\left(\frac{1403}{1{,}000{,}000}\right) = \tan^{-1}(0.001403) = 0° \; 5' \; 3''.$$

As this large gradient would give very rapid horizontal motions there is too much power to be expended in this simple manner. The warm mass is really rising and the cold mass falling simultaneously, not vertically but toward each other in the manner indicated by the diagrams, figs. 9, 10.[5] In these, and from other descriptions of the prevailing circulation found in the reports of the Weather Bureau, we infer that in all of the levels the cold current flows southeastward toward the warm area, while the warm current flows northwestward toward the cold area.

This flow is *not directly toward the respective centers* of the warm and cold waves, making the currents meet along an axis,

[4] See Monthly Weather Review for June, 1906, pp. 267-271.
[5] See Monthly Weather Review, February, 1906, pp. 77-78 and lithograph plate at the end.

because this would produce a congestion of the density and make the flow impossible. The system of internal reactions in the circulating fluid, in combination with the deflecting force due to the earth's rotation, will cause the stream lines to flow about the center up to a certain limited amount of congestion on the outer circles. It is evident that a compromise or resultant between these opposite tendencies must be brought about, and then the stream lines will approximate to spirals converging toward the center in the cyclone, but diverging in the anticyclone. In order to avoid the congestion, a vortex motion is thus established with an ascending component over all areas contained within the closed isobars of the cyclone, but descending in the anticyclone. The conflict of this localized circulation with the general circulation, the continuous absorption of the former by the latter, produces the entire observed cyclone system. Quite similar reasoning accounts for the downward component in the anticyclone, which is generated and fed from the other portions of the cold and warm areas, since it has been shown that both of these masses divide into two branches and are absorbed in consecutive high and low pressure areas.

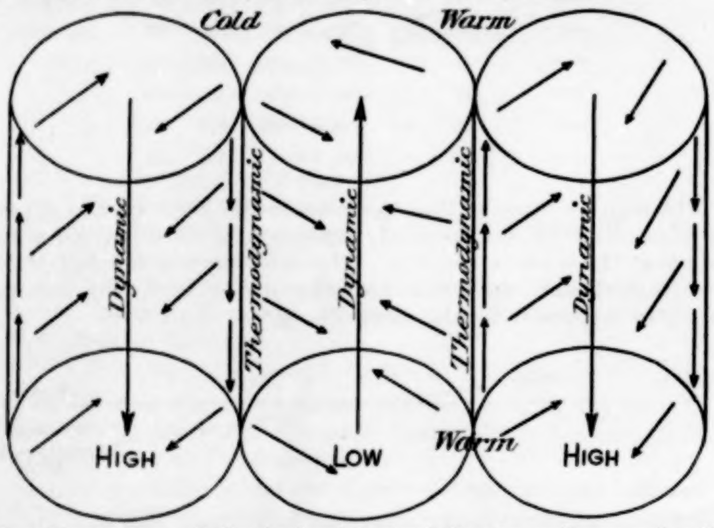

FIG. 21.—Scheme of the horizontal circulation in cyclones and anticyclones.

In the low area, in the strata from the surface to about 4000 meters, to the southward of the center, the cold mass tends to underrun the warm mass, while to the northward of the center in the strata above 4000 meters, the warm mass tends to overflow the cold mass. On the other hand, in the high pressure area, similar conditions exist tho the sectors or quadrants are inverted in their order. The cold air near the surface separates or divides into two branches, which tend to underrun the warm areas on either side, and in the high levels the warm air divides into two branches which tend to overflow the adjacent cold masses on either side.

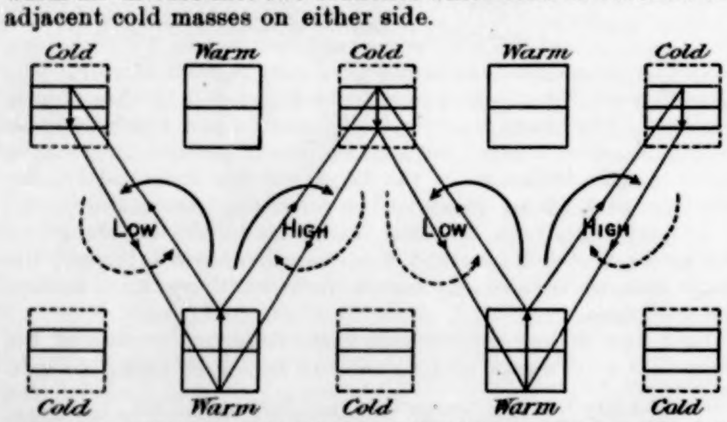

FIG. 22.—Illustrating the relation of the thermodynamic gradients to the hydrodynamic pressures in cyclones and anticyclones.

In the warm areas the isobars are farther apart than in the cold areas, and by the ordinary rules the circulations are in the directions indicated. The warm mass divides into two branches which overflow the cold masses to the north, while the cold mass divides into two branches which underrun the warm masses to the south. The outcome is to produce more stable equilibrium by superposing air of less potential density upon air of greater potential density. At the same time there is an interchange of heat and a manifestation of dynamic energy in the form of large and small vortices on the horizontal planes with dynamic components in the vertical directions. In this process there are involved: (1) an interchange of heat; (2) a more stable equilibrium, since gravity has pulled the air of great potential density downward, while that of lower potential density is pushed up; (3) an amount of kinetic energy corresponding to the movements of the air masses from one level surface to another; (4) important horizontal motions with minor vortex motions whose kinetic energy represents a large fraction of that mentioned in the preceding item.

THE HORIZONTAL PRESSURE GRADIENTS.

In order that the reason for this overflow of warm masses upon cold masses in the upper strata, with underflow of cold masses beneath warm masses in the lower strata may be evident, we need only compute the pressures B in the several strata of the warm and cold masses, respectively, from the surface up to 10,000 meters. Combine the temperatures given in Table 21[6] thus: Take the mean of the temperatures of the east sector of the high area and the west sector of the low area for the mean temperature in the cold mass, and the mean of the temperatures of the west sector of the high area and the east sector of the low area for the mean temperature of the warm mass, on each of the 1000-meter levels. The result will be found in Table 43, Section II, and is transferred to the first column of the cold and warm masses in Table 42, and marked t.

The mean t of the successive strata gives the mean temperature of the air column, $\theta = \frac{t_z + t_{z-1}}{2}$, in the second column. This is the argument for m in Table 91, International Cloud Report, and we may assume that the observed t is the virtual temperature, and that it includes the dry air and the vapor contents as they occur. With H the height and θ as arguments, the value of m is extracted. It is now necessary to assume some value of the pressure B at the surface in warm and cold areas, independent of any variation due to the circulation in the high and low areas, and I have taken two pressures, 10 millimeters different, as fairly representing known surface pressures under the prescribed conditions. Thus, for 770 millimeters in the cold mass, we shall have 760 millimeters in the warm mass, as the barometric pressure at the surface. Adopt these values, take log B, 2.88649 in the cold area, 2.88081 in the warm area, add successively the m on the several levels, and then take the corresponding B_c, B_w. Comparing B_c with B_w it is seen that the cold area pressure is greater than the warm area pressure up to 4000 meters, and that the warm area pressure is greater than the cold area pressure above that level. Hence, cold air flows to warm areas below, while warm air flows to cold areas above 4000 meters, conforming to well-recognized principles.

We can compute the vertical distance thru which 1 millimeter of air extends in the several levels. Take the difference between the pressures in the successive 1000-meter levels, $B - B_0$, the second difference, $\Delta (B - B_0)$, showing the variation with the height, then divide 1000 by $B - B_0$ for Δz, the required height in meters thru which 1 millimeter of air, that is the weight of air measured by 1 millimeter of mercury, extends. It changes from 11 meters near the surface to 31 meters near the 10,000-meter level, and shows the spaces that exist in a vertical direction between successive isobaric surfaces.

[6] Page 268, Monthly Weather Review, June, 1906.

Since the tendency of gravity is to make these spaces equal in the same stratum, a circulation is set up to bring this about; this is the flowing of the air which, thereupon, builds up the observed cyclones and anticyclones in combination with the other forces, inertia, expansion and contraction, deflection, centrifugal, friction, and internal vortical motion. This complex network of forces can be reduced to a rigid analytic discussion only with the greatest difficulty, even without the term involving the interchange of heat energy into velocity, and it seems nearly useless to attempt it until further experimental knowledge of this process in the free air has been obtained by a careful discussion of the temperature conditions observed in balloon and kite ascensions.

TABLE 42.—*Computation of the pressure B in the cold and warm maxima on each 1000-meter level.*

Height in meters.	In cold masses. t	θ	m	B_c	B_c	In warm masses. t	θ	m	B_w	B_w
	°C.	°C.		log.	mm.	°C.	°C.		log.	mm.
10000...	−56.6			2.28423	192.41	−51.7			2.29445	196.99
		−53.6	6796				−48.4	6595		
9000...	−50.5			2.35219	225.01	−45.0			2.36040	229.30
		−47.2	6561				−41.4	6397		
8000...	−43.8			2.41780	261.70	−37.8			2.42437	265.69
		−40.5	6371				−34.1	6200		
7000...	−37.1			2.48151	303.05	−30.4			2.48637	306.46
		−33.9	6195				−26.8	6016		
6000...	−30.6			2.54346	349.51	−23.1			2.54653	351.99
		−27.5	6033				−19.7	5849		
5000...	−24.3			2.60379	401.60	−16.2			2.60502	402.74
		−21.3	5885				−13.4	5705		
4000...	−18.2			2.66264	459.86	−10.6			2.66207	459.27
		−15.5	5752				− 8.3	5595		
3000...	−12.7			2.72016	525.00	− 5.9			2.71802	522.42
		−10.2	5636				− 3.7	5499		
2000...	− 7.6			2.77652	597.75	− 1.6			2.77301	592.94
		− 5.5	5536				0.0	5425		
1000...	− 3.3			2.83188	679.02	+ 1.7			2.82726	671.83
		− 0.8	5461				+ 3.5	5355		
0...	+ 1.7			2.88649	770.00	+ 5.2			2.88081	760.00

Vertical distance for 1 mm. of pressure between strata of different temperature.

Height.	$B-B_0$	$\Delta(B-B_0)$	$(B-B_0)$	Δ_z	Δ_z	$B-B_0$	$\Delta(B-B_0)$	$(B-B_0)$	Δ_z	Δ_z
	mm.	mm.	log.	log.	mm.	mm.	mm.	log.	log.	mm.
10000...										
	32.60		1.51322	1.48678	30.68	32.31		1.50934	1.49066	30.95
9000...		4.09					4.08			
	36.69		1.56455	1.43545	27.25	36.39		1.56098	1.43902	27.48
8000...		4.66					4.38			
	41.35		1.61648	1.38352	24.18	40.77		1.61034	1.38966	24.53
7000...		5.11					4.76			
	46.46		1.66708	1.33291	21.52	45.53		1.65830	1.34170	21.96
6000...		5.63					5.22			
	52.09		1.71675	1.28325	19.20	50.75		1.70544	1.29456	19.70
5000...		6.17					5.78			
	58.26		1.76537	1.23463	17.16	56.53		1.75228	1.24772	17.69
4000...		7.08					6.62			
	65.14		1.81385	1.18615	15.35	63.15		1.80037	1.19963	15.84
3000...		7.61					7.37			
	72.75		1.86183	1.13817	13.75	70.52		1.84831	1.15169	14.18
2000...		8.52					8.37			
	81.27		1.90993	1.09007	12.30	78.89		1.89702	1.10298	12.68
1000...		9.71					9.28			
	90.98		1.95895	1.04105	10.99	88.17		1.94532	1.05468	11.34
0...										

THE HORIZONTAL INTERCHANGE OF HEAT ENERGY.

We can secure some idea of the process involved in the interchange of the heat energy on the horizontal surfaces by a computation of the formula:

Term I Term II

$$C_p\, n_0\, (T_1 - T) + C_p\, T_0 \log T_0\, (n_1 - n) = (Q_1 - Q) - \tfrac{1}{2}\, (q_1^2 - q^2).$$

The necessary data are collected in Table 43, and they are gathered in the same way as described for the temperatures, by combining the sectors of cold and of warm masses, respectively. The mean value of the gradient ratio n is found by extracting n from Tables 25 and 26, and taking the means, n for cold areas and n_1 for warm areas. Then the difference, $n_1 - n$, and the mean, $n_0 = \frac{1}{2}\,(n + n_1)$, are taken out for use in the formula. We adopt the notation (n, t, q, Q) for the cold mass, (n_1, t_1, q_1, Q_1) for the warm mass, and (n_0, t_0, q_0, Q_0) the mean values of the cold and warm masses when required.

75——2

TABLE 43.

I.—*Mean values of the gradient ratio n in the cold and warm maxima.*

Height in meters.	Ratio. n High east.	Low west.	Mean cold.	Ratio. n_1 High west.	Low east.	Mean warm.	n_1-n W—C.	Mean n_0
10000......	1.778	1.659	1.718	1.535	1.547	1.541	−.177	1.630
9000......	1.537	1.500	1.518	1.319	1.458	1.389	−.129	1.454
8000......	1.495	1.443	1.469	1.246	1.447	1.347	−.122	1.408
7000......	1.523	1.447	1.485	1.234	1.471	1.353	−.132	1.419
6000......	1.567	1.498	1.533	1.272	1.518	1.395	−.138	1.464
5000......	1.623	1.562	1.593	1.430	1.629	1.530	−.063	1.562
4000......	1.725	1.690	1.708	1.974	1.766	1.870	+.162	1.789
3000......	1.894	1.876	1.885	2.443	1.974	2.209	+.324	2.047
2000......	2.285	2.150	2.218	3.056	2.518	2.787	+.569	2.503
1000......	2.179	2.213	2.196	3.439	2.611	3.025	+.829	2.611
000......	1.769	2.065	1.917	3.290	2.367	2.829	+.912	2.373

II.—*Mean values of the temperature T in the cold and warm maxima.*

Height in meters.	Temperature. t High east.	Low west.	Mean cold.	Temperature. t_1 High west.	Low east.	Mean warm.	t_1-t W-C.	Mean T_0 $t_0+273°$	Log. T_0
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	Abs.	
10000......	−56.2	−57.0	−56.6	−52.2	−51.2	−51.7	+4.9	218.8	2.34005
9000	−50.2	−50.7	−50.5	−45.3	−44.7	−45.0	+5.5	225.2	2.35257
8000......	−43.6	−43.9	−43.8	−37.6	−37.9	−37.8	+6.0	232.2	2.36586
7000......	−37.1	−37.1	−37.1	−29.6	−31.1	−30.4	+6.7	239.2	2.37876
6000	−30.7	−30.5	−30.6	−21.7	−24.5	−23.1	+7.5	246.1	2.39111
5000......	−24.6	−24.0	−24.3	−14.3	−18.0	−16.2	+8.1	152.7	2.40261
4000......	−18.6	−17.8	−18.2	− 8.7	−12.5	−10.6	+7.6	258.6	2.41263
3000......	−13.0	−12.4	−12.7	− 4.2	− 7.6	− 5.9	+6.8	263.7	2.42111
2000......	− 8.0	− 7.2	− 7.6	− 0.2	− 3.0	− 1.6	+6.0	268.4	2.42878
1000......	− 3.7	− 2.8	− 3.3	+ 2.7	+ 0.7	+ 1.7	+5.0	272.2	2.43489
000......	+ 1.5	+ 1.9	+ 1.7	+ 5.6	+ 4.7	+ 5.2	+3.5	276.5	2.44170

III.—*Mean values of the velocity term in the cold and warm maxima.*

Height in meters.	Velocity. $\frac{1}{2}(q_1^2-q^2)$ High west.	Low east.	Mean warm.	Velocity. $\frac{1}{2}(q_1^2-q^2)$ High east.	Low west.	Mean cold.	Average.
10000	+54	+175	+115	−127	− 95	−111	113
9000.....	+56	+216	+136	−122	−122	−122	129
8000	+72	+228	+150	−101	−132	−117	134
7000......	+72	+220	+146	− 91	−121	−106	126
6000......	+65	+160	+113	− 83	− 83	− 83	98
5000......	+88	+ 88	+ 88	− 74	− 50	− 62	75
4000......	+72	+ 72	+ 72	− 56	− 32	− 44	58
3000......	+60	+ 86	+ 73	− 58	− 14	− 36	55
2000	+10	+ 52	+ 31	− 28	− 28	− 28	30
1000......	+ 3	+ 19	+ 11	− 12	− 25	− 19	15
000......	+ 8	+ 18	+ 13	− 8	− 8	− 8	11

These data are given in Section I of Table 43; the temperature data in Section II of that table are taken from Tables 21 and 22; T_0 and log T_0 are computed; finally, $\frac{1}{2}\,(q_1^2 - q^2)$ are taken from Tables 33 and 34. Since the velocity energy is a small term in comparison with $(Q_1 - Q)$, there is no need to be particular about the exact velocities, and approximate values are sufficient. In order to learn the relation between the values of the ratio n, n_1 in cold and warm areas in the

several strata, they are plotted in fig. 23. It is seen that the curves cross each other between the 4000 and the 5000-meter level, showing that there is a reversal of the physical process at that elevation, as warming below and cooling above, so that the cold mass is warming below and the warm mass is cooling above in conformity with the preceding statements. Since the adiabatic gradient is $-9.87°$ C. per 1000 meters, and $a = \frac{a_0}{n}$, we find the gradients corresponding with n at the several levels by using the lower horizontal argument in the diagram.

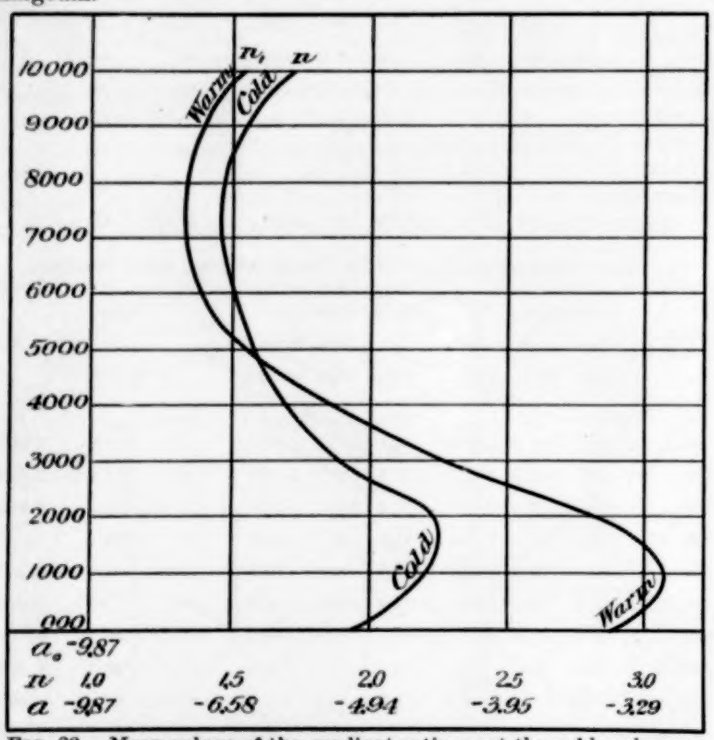

FIG. 23.—Mean values of the gradient ratio, n, at the cold and warm maxima.

The computation of the terms $\mathrm{I} = C_p\, n_0\, (T_1 - T)$ and $\mathrm{II} = C_p T_0 \log T_0\, (n_1 - n)$ gives the results that are found in Table 44, for the several 1000-meter levels. Term I is positive for all levels, and term II reverses the sign at about the 5000-meter level. The sum I + II is reduced to calories by the factor $A_m = 0.0002389$ in Table 14.[7] In the last column of Table 44, a mean value of $\frac{1}{2}\,(q_1^2 - q_0^2)$ is added as computed by Section III, Table 43. A comparison of columns 4 and 6 shows how small the velocity term is in comparison with the heat term. An unknown (R) is added in the formula to represent the waste of energy in passing thru friction into motion. It stands between the energy and velocity terms, but can not be evaluated, and it is presupposed in the unexpress function that connects heat with motion. In the same way there is the unknown radiation term, J, wherein some heat energy is wasted so far as the motion of the atmosphere is concerned. The function uniting $(Q_1 - Q) - \frac{1}{2}(q_1^2 - q_0^2) + (R) + (J)$ being undetermined, it is very difficult to make satisfactory progress in this direction, and the problem must wait for further developments. Reviewing columns I + II in calories, which is the heat energy available from the temperature distribution, it is seen that it is positive and diminishes up to the 5000-meter level, above which it is small and negative. Comparing this column with Tables 37 and 38 it is observed that the vertical heat potentiality is about the same as the horizontal capacity for motion. If a kilogram of air is moved as noted by the conditions of the problem, this amount of heat must be interchanged. In the actual atmosphere this transfer is not so simple, and hence only a portion of the Q-energy is actually produced. How much less is really generated depends upon the efficiency of the thermodynamic engine in the practical physical operations of the air.

[7] See Monthly Weather Review, March, 1906, page 115.

TABLE 44.—*Values of the terms in the formula,*

$$\overset{\mathrm{I}}{C_p\, n_0\, (T_1 - T)} + \overset{\mathrm{II}}{C_p\, T_0 \log T_0\, (n_1 - n)}$$
$$= (Q_1 - Q) - \tfrac{1}{2}\,(q_1^2 - q^2) + R + J.$$

Energy terms in the horizontal convection.

Height in meters.	I	II	I+II	I+II in calories.	$\frac{1}{2}(q_1^2-q^2)$
10000......	7936	−90042	−82106	− 19.6	113
9000	7946	−67905	−59959	− 14.3	129
8000......	8394	−66587	−58193	− 13.9	134
7000......	9443	−74624	−65181	− 15.6	126
6000......	10909	− 80684	−69775	− 16.7	98
5000......	12571	−38004	−25433	− 6.1	75
4000......	13509	100427	113936	+ 27.2	58
3000.....	13830	205529	219359	+ 52.4	55
2000......	14921	368533	383454	+ 91.6	30
1000......	12971	545913	558884	+133.5	15
0......	8252	611771	620023	+148.1	11

SOME CASES OF RESTRICTED CONDITIONS.

In order to approach this intricate problem by a mathematical analysis, it will be desirable to study some simpler cases, or models, wherein the conditions are limited by ideal restrictions. These consist in placing two masses of air in adjoining chambers, or in one chamber with a movable partition, whereby two fixed masses under given conditions when set into communication react upon each other. Dr. M. Margules has made several such studies in his paper, Über die Energie der Stürme, and for the sake of profiting by this excellent work, I have prepared a brief synopsis of the results as *modified by myself to meet nonadiabatic conditions.* It is proposed to give the assumed data and the resulting formula, omitting the algebraic reductions, and to urge that the student should not fail to read that paper. In order to preserve the notation of my formula, the following table of equivalents will be useful:

	Margules.	*Bigelow.*
External kinetic energy	K to	$(K) = \frac{1}{2}\int \rho\, q^2\, d\,v = \frac{1}{2}\, m\, q^2.$
External potential energy	P to	$V = \int \rho\,(-g\,r + \frac{1}{2}\, w_0^2\, \varpi^2)\, d\,v.$
Internal kinetic energy / Internal potential energy	I to	$U = \left\{ \begin{matrix} H_m\,(\text{molecules}) + H_a\,(\text{atoms}) \\ J_m\,(\text{molecules}) + J_a\,(\text{atoms}) \end{matrix} \right\} = C_v \int T \rho\, d\,v.$
Quantity of heat		$Q = \int d\,t \int \frac{d\,Q}{d\,t}\, \rho\, d\,v.$
Work of expansion	A to	$-\mathrm{W} = -\int d\,t \int \frac{p}{\rho}\frac{d\,\rho}{d\,t}\, d\,v = \int d\,t \int p\, v\, \frac{d\,\frac{1}{v}}{d\,t}\, d\,v.$

	Margules.		Bigelow.
Potential energy + centrifugal force	W	to	$V_1 = -g r + \frac{1}{2} w_0^2 \varpi^2$.
Friction			$(R) = -\int d t \int R q \cos (R q) \rho \, d v$.
Velocity	c, V	to	q
Volume	k	to	v
Density	μ	to	ρ
Ratio of specific heats	γ	to	$k = \frac{C_p}{C_v}$.
Adiabatic constant	$\frac{1}{\varkappa}$	to	$\frac{k}{k-1} = \frac{C_p}{R} = \frac{g_0}{R a_0}$.
Height	c	to	h
Surface	O	to	S
Entropy temperature	θ	to	T_0
Potential temperature	τ	to	T_0
Drive temperature	ϑ	to	T_0

GENERAL THERMODYNAMIC EQUATIONS.

(1) Conservation of energy.

$$\delta (K) + \delta V - \delta W + (R) = 0.$$

$$Q = \delta U + \delta W + (R) = \delta (K) + \delta V + \delta U + (R).$$

$$Q = [\delta (K) + \delta V] \text{ external} + [\delta H + \delta J] \text{ internal} = \delta W + \delta U.$$

(2) Variation of heat.

External work. Internal heat.

$$d Q = R T \frac{d v}{v} + \frac{1}{A} C_v \, d T.$$

$$d Q = -R T \frac{d p}{p} + \frac{1}{A} C_p \, d T.$$

$$d Q = p \, d v + \frac{v \, d p + p \, d v}{A R}.$$

in mechanical units.

(3) External potential energy.

$$V = \int_0^\infty g z \rho \, d z = \int_0^h g z \rho \, d z + g z M_h. \qquad p_h = g M_h = g \rho h.$$

$$V = \quad = -\int_p^{p_h} z \, d p + Z p_h = + \int_0^h p \, d z - z p_h + Z p_h.$$

$$V = \int_0^h p \, d z + (Z - z) p_h = R \int T \, d m + \text{const.}$$

(4) Internal energy. $U = C_v \int T \, d m + \text{const.}$

$$(U + V) = (C_v + R) \int T \, d m + \text{const.} = C_p \int T \, d m + \text{const.}$$

(5) Transformation of energy.

$$-\delta (U + V) = (U + V)_a (\text{initial}) - (U + V)_e (\text{final}) = C_p \int (T - T^1) \, d m.$$

$$\delta (K) + (R) = \tfrac{1}{2} M q^2 = C_p \int (T - T^1) \, d m = C_p (T - T^1) M.$$

(6) Entropy variations.

$$S - S_0 = \int \frac{d Q}{T} = C_v \log \frac{T}{T_0} + R \log \frac{v}{v_0}.$$

$$S - S_0 = \int \frac{d Q}{T} = C_p \log \frac{T}{T_0} - R \log \frac{p}{p_0}.$$

$$\frac{\partial S}{\partial z} = \frac{1}{T} \frac{\partial Q}{\partial z} = \frac{C_p}{T} \frac{\partial T}{\partial z} - \frac{R}{p} \frac{\partial p}{\partial z}.$$

(7) Potential temperature.

$$T_0 = T \left(\frac{P_0}{P} \right)^{\frac{k-1}{k}}.$$

(8) In linear vertical changes.

$$\int_0^h T \, d m = \frac{1}{g} \, \frac{1}{1 + \frac{k-1}{n k}} (p_0 T_0 - p T).$$

(9) Auxiliary equations.

$$\frac{\rho}{\rho_0} = \left(\frac{T}{T_0}\right)^{\frac{n}{k-1}} = \left(\frac{P}{P_0}\right)^{\frac{1}{k}} = \frac{v_0}{v}.$$

$$\frac{P}{P_0} = \left(\frac{T}{T_0}\right)^{\frac{nk}{k-1}} = \left(\frac{\rho}{\rho_0}\right)^{k} = \left(\frac{v_0}{v}\right)^{k}.$$

Adiabatic. Observed.

$$\frac{k}{k-1} = \frac{C_p}{R} = \frac{g}{Ra_0}. \qquad \frac{nk}{k-1} = \frac{nC_p}{R} = \frac{g}{Ra}. \qquad a = \frac{a_0}{n} = \frac{g}{nC_p}.$$

$$\frac{1}{\rho} = \frac{1}{P} R\,T. \qquad \frac{1}{\rho}\frac{dP}{dz} = -\,g. \qquad \frac{1}{P}\frac{dP}{dz} = -\frac{1}{RT}\,g.$$

CASE I. CHANGE OF POSITION OF THE LAYERS IN A COLUMN OF AIR.

In consequence of the general and local circulations of the

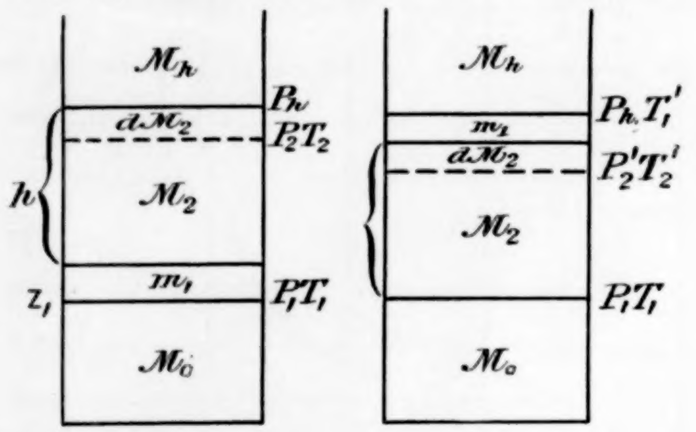

FIG. 24 A. Initial. Final.

atmosphere, a certain gradient $a = \frac{a_0}{n}$ prevails at a given locality in a column above the earth's surface. This requires an amount of heat Q_0 and a temperature T_0 at each level z_0 to maintain the stratum in equilibrium. If the heat energy changes to Q for any reason or the temperature is altered to T there must follow a change in elevation to z to restore the equilibrium. The equation of equilibrium,

$$(10) \quad \tfrac{1}{2}(q^2-q_0^2) = (Q-Q_0) - C_p n\,(T-T_0) - C_p T_0 \log T_0\,(n-n_0) - g\,(z-z_0),$$

is available for the computation of the motion due to stratifications in the column. In order to take a simple case we assume that each air mass retains its own heat energy or $Q = Q_0$, and that the gradient is the same thruout the column or $n = n_0$. Hence when starting from rest or $q = 0$, the equation becomes for the unit mass.

$$(11) \qquad \tfrac{1}{2}\,q^2 = -C_p\,n\,(T-T_0) - g\,(z-z_0).$$

This must be applied to each mass moved, so that finally

$$(12) \quad \tfrac{1}{2}\,m\,q^2 = \sum \Big[-C_p\,n\,(T-T_0) - g\,(z-z_0)\Big]\,m.$$

Let the column be separated from the surrounding air by walls and consist of four parts. M_0 is a lower section not affected by the transfer; the next layer m_1, under pressure P_1 and temperature T_1, is not in equilibrium, so that the stratified layer m_1 must rise if T_1 is too warm and fall if T_1 is too cold for its elevation z_1. If it rises thru a height $h = z_2 - z_1$, and by expanding cools to a given temperature T_1^1, the pressure P_1 will become P_h and be in equilibrium; the section M_2 of thickness h falls a certain distance and changes its temperature; for the upper differential layer $d\,M_2$ the initial values $P_2\,T_2$, become P_2^1, T_2^1, and the function must be integrated thruout the mass M_2; the temperature of the mass M_h is not affected by the mutual transfer of $m_1\,M_2$, but rises or falls like a piston in the chamber, while its lower surface maintains the pressure P_h. Hence, we have the conditions,

Layer.	Initial.	Final.	Pressure.
$d\,M$	$P_2\;T_2$	$P_2^1\;T_2^1$	$P_2^1 = P_2 + g\,m_1$
m_1	$P_1\;T_1$	$P_h\;T_1^1$	$P_1 = P_h + g\,M_2$

$$(13) \quad T_2^1 = T_2\left(\frac{P_2^1}{P_2}\right)^{\frac{k-1}{nk}} = T_2\left(1 + \frac{g\,m_1}{P_2}\right)^{\frac{k-1}{nk}} = T_2\left(1 + \frac{k-1}{n\,k}\,\frac{g\,m_1}{P_2}\right)$$

$$= T_2 + T_2\,\frac{R}{n\,C_p}\,\frac{g\,m_1}{P_2}.$$

$$(14) \quad T_1^1 = T_1\left(\frac{P_h}{P_1}\right)^{\frac{k-1}{nk}}.$$

Substituting in the equation,

$$(15) \quad \text{Kinetic energy} = C_p\left[\int (T_1 - T_1^1)\,d\,m_1 + \int (T_2 - T_2^1)\,d\,M_2\right].$$

$$(16) \qquad \tfrac{1}{2}\,m_1\,q^2 = C_p\left[\,T_1 - T_1\left(\frac{P_h}{P_1}\right)^{\frac{k-1}{nk}}.\right]m_1 - g\,\frac{h}{n}\,m_1,$$

since

$$(17) \qquad \frac{RT_2}{P_2}\int\frac{d\,M_2}{n} = \int\frac{d\,M_2}{n\rho_2} = \int\frac{d\,z}{n} = \frac{h}{n}.$$

The gravity terms in these equations disappear, because the mechanical work in each case, $g\,h\,M_1$ and $g\,(Z_2 - Z^1_2)\,M_2$ (where Z_2 is the height of the center of gravity of M_2) is of the same amount and oppositely directed. Every expansion or contraction of air masses begins on an adiabatic gradient, and hence the formulas must be founded on that basis. But minor interchanges of energy as heat Q and velocity $\frac{1}{2}q^2$ almost immediately begin in the mixing process, so that the theoretical conditions soon suffer modifications which it is quite impracticable to follow out.

CASE II. THE TEMPERATURE IS A CONTINUOUS FUNCTION OF THE HEIGHT, $T_2 = T_1 - a\,h$.

It is important to eliminate the pressures from the formula and express the function in terms of g, h, T, and the gradients. Several forms of the function for the temperature distribution may be employed to represent the atmosphere, but it is only occasionally that these formulas can be used to replace the actual pressure and temperature observations at different levels. For the observed gradient we have

$$(18) \quad \text{Observed gradient.} \quad \frac{P_h}{P_1} = \left(\frac{T_2}{T_1}\right)^{g/_{Ra}} = \left(\frac{T_1 - ah}{T_1}\right)^{g/_{Ra}}.$$

Hence,

$$(19)\quad \left.\begin{array}{r}\text{Adiabatic}\\ \text{gradient.}\end{array}\right\}\left(\frac{P_h}{P_1}\right)^{\frac{k-1}{k}}=\left(1-\frac{ah}{T_1}\right)^{g/_{Ra}\,\frac{k-1}{k}}=\left(1-\frac{ah}{T_1}\right)^{g/C_p a}$$

Then,

$$(20)\quad C_p m_1(T_1-T_1^1)=C_p m_1\left(T_1-T_1+\frac{gh}{C_p}-\tfrac{1}{2}\frac{g^2h^2}{C_p^2 T_1}+\frac{\tfrac{1}{2}gh^2a}{C_p T_1}\right).$$

Finally,

$$(21)\quad \tfrac{1}{2}m_1q^2=ghm_1-\tfrac{1}{2}\frac{gh^2}{C_pT_1}\cdot\frac{g}{C_p}+\tfrac{1}{2}\frac{gh^2}{C_pT_1}\cdot a-ghm_1$$

$$=\tfrac{1}{2}\frac{gh^2}{T_1}m_1\left(a-\frac{g}{C_p}\right),$$

$$=\tfrac{1}{2}\frac{gh^2}{T_1}m_1\left(\frac{a_0}{n}-a_0\right).$$

The mass m_1 is driven from its position with a velocity-energy inversely proportional to the temperature, so that warm air has less driving power than cold air. The drive depends upon the departure-ratio n and vanishes when $n=1$, that is, for an adiabatic expansion in an adiabatic gradient. When $a>a_0$ the mass m_1 is in unstable equilibrium—is too cold for its position and tends to fall. Example, for $n=0.5$, $a=19.74>a_0=9.87$. When $a<a_0$ the mass m_1 is in stable equilibrium. Example, for $n=2$, $a=4.94<a_0=9.87$ It is not possible to drive the small mass m_1 thru any great height h in the atmosphere, because the differential energy in the expanding mass sets up minor whirls which tend to interchange the Q-energy by mechanical effects and internal friction.

The result is to change the gradient from a_0 to $a=\frac{a_0}{n}$. If the displacement of the mass m_1 takes place in the medium of gradient a then the drive may be exprest by terms of the form,

$$(22)\quad \tfrac{1}{2}g\frac{h^2}{T_1}m_1\left(\frac{a_0}{n_1}-\frac{a_0}{n}\right)=\tfrac{1}{2}\frac{gh^2}{T_1}a_0\left(\frac{n-n_1}{nn_1}\right),$$

where n_1 is the effective ratio of the moving mass m_1 and a that of the prevailing general gradient.

CASE III. FOR LOCAL CHANGES BETWEEN TWO ADJACENT STRATA OF DIFFERENT TEMPERATURES, WHERE ON THE BOUNDARY THE PRESSURE $P=P_1^1=P_2^1$, AND THE TEMPERATURE IS DISCONTINUOUS.

Take the following conditions:

Layer.	Initial.	Final.	Pressure.	Temperature.
m_2	$P_2\,T_2$	$P_2^1\,T_2^1$	$P_2^1=P_2+gm_1$	$T_2^1=T_2\left(\frac{P_2+gm_1}{P_2}\right)^{\frac{k-1}{nk}}$
m_1	$P_1\,T_1$	$P_1^1\,T_1^1$	$P_1^1=P_1-gm_2$	$T_1^1=T_1\left(\frac{P_1-gm_2}{P_1}\right)^{\frac{k-1}{nk}}$.

The equation of equilibrium becomes, for $P^1_1=P^1_2=P$,

$$(23)\quad \begin{array}{l}\text{Kinetic}\\ \text{energy}\end{array}=C_p\left[m_1(T_1-T^1_1)+m_2(T_2-T^1_2)\right],$$

$$=C_p\left[m_1(T_1-T_1+T_1\frac{R}{nC_p}\frac{gm_2}{P})\right.$$

$$\left.+m_2(T_2-T_2-T_2\frac{R}{nC_p}\frac{gm_1}{P})\right],$$

$$=m_1m_2\frac{Rg}{nP}(T_1-T_2),$$

$$=m_1m_2\frac{g}{n}\left(\frac{1}{\rho_1}-\frac{1}{\rho_2}\right).$$

Since $\frac{RT_1}{P_1}=\frac{1}{\rho_1}$ and $\frac{RT_2}{P_2}=\frac{1}{\rho_2}$, therefore

$$(24)\quad \tfrac{1}{2}Mq^2=m_1m_2\frac{g}{n}\frac{\rho_2-\rho_1}{\rho_1\rho_2}.$$

The kinetic energy inducing an interchange is proportional to the difference of the densities and inversely proportional to the product of the densities. Hence, if strata of different densities are flowing over one another in the general circulation which is temporarily stratified, these two strata tend to mix by interpenetration according to this law.

AUXILIARY THEOREM. EVALUATION OF $\int T\,dm$ IN LINEAR VERTICAL TEMPERATURE CHANGES.

$$(25)\quad \text{Assume } T=T_0-az,\qquad P=P_0\left(\frac{T}{T_0}\right)^{g/_{Ra}},\qquad \int T\,dm=\int T\rho\,dz.$$

$$\int_0^z T\rho\,dz=\frac{1}{R}\int_0^z P\,dz=\frac{1}{R}\int_0^z P_0\left(\frac{T}{T_0}\right)^{g/_{Ra}}dz=\frac{1}{R}\int_0^z P_0\,T^{/_{Ra}}\,T_0^{-g/_{Ra}}\,dz$$

Change the limits of integration from z to T.

$$(26)\quad T=T_0-az,\quad dT=-a\,dz,\quad -\frac{1}{a}\,dT=dz,\quad \int_0^z T^x\,dz=-\frac{1}{a}\int_{T^0}^{T}T^x\,dT.$$

$$(27)\quad \int_0^z T\rho\,dz=\frac{1}{Ra}\,P_0\,T_0^{-g/_{Ra}}\int_T^{T_0}T^{g/_{Ra}}\,dT=\frac{1}{Ra}\,P_0T_0^{-g/_{Ra}}\left[{}_T^{T_0}\,\frac{1}{1+g/Ra}\,T^{g/_{Ra}+1}\right]$$

$$=\frac{1}{g+Ra}\,P_0\,T_0^{-g/_{Ra}}\left(T_0^{g/_{Ra}+1}-T^{g/_{Ra}+1}\right)=\frac{1}{g+Ra}\,(P_0\,T_0-P\,T).$$

For any gradient other than the adiabatic we have,

$$(28)\quad \int_0^z T\rho\,dz=\frac{1}{g}\,\frac{1}{1+\frac{k-1}{nk}}\,(P_0\,T_0-P\,T).$$

CASE IV. THE OVERTURN OF DEEP STRATA IN THE COLUMN.

Let the pressures, temperatures, and heights be arranged in the initial and final states as indicated in the diagrams (fig. 24 B). The greatest entropy in 1 is less than the least in 2, so that the cold mass 1 will fall beneath the warm mass 2. The heights of the masses will change as well as the pressures and temperatures.

Assume P_0, T_{02}, h_2, T_{i1}, h_1, as known in the initial state.

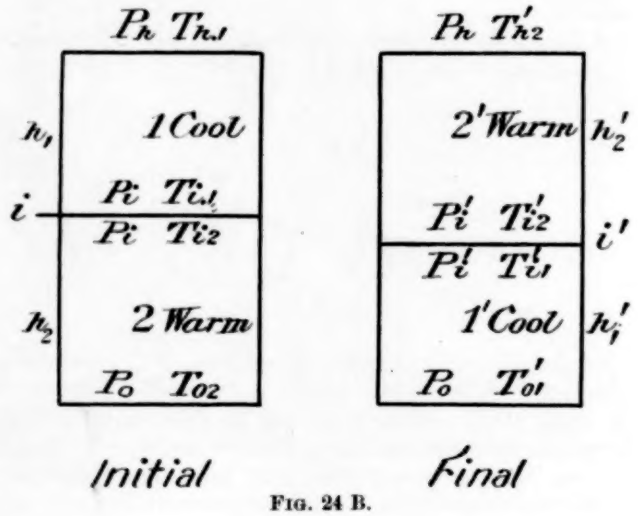

FIG. 24 B.

Pressures. Temperatures.

(29) $P_i = P_0\left(\frac{T_{i2}}{T_{02}}\right)^{\frac{nk}{k-1}}$. $T_{i2} = T_{02} - \frac{g h_2}{n C_p}$.

(30) $P_h = P_i\left(\frac{T_{h1}}{T_{i1}}\right)^{\frac{nk}{k-1}}$. $T_{h1} = T_{i1} - \frac{g h_1}{n C_p}$.

Substitute in $C_p\left(\int T\,dm - \int T_1\,dm_1\right)$ successively.

(31) Initial, $(V+U)_a = C_p\int T\,dm = \frac{C_p}{g}\,\frac{1}{1+\frac{k-1}{nk}}\,(P_0 T_{02} - P_i T_{i2} + P_i T_{i1} - P_h T_{h1}) + \text{const.}$

(32) Final, $(V+U)_e = \frac{C_p}{g}\,\frac{1}{1+\frac{k-1}{nk}}\,(P_0 T_{01}^1 - P_i^1 T_{i1}^1 + P_i^1 T_{i2}^1 - P_h T_{h2}^1) + \text{const.}$

(33) Kinetic energy $= (V+U)_a - (V+U)_e = \frac{1}{2} M q^2 = \frac{1}{2}\,\frac{P_0 - P_h}{g}\,q^2$.

(34) Heights, $h_1^1 = \frac{nC_p}{g}(T_{01}^1 - T_{i1}^1)$, $h_2^1 = \frac{nC_p}{g}(T_{i2}^1 - T_{h2}^1)$.

(35) Approximate solution of Case IV. $\frac{1}{2} q^2 = \frac{g}{n}\,\frac{h_1 h_2 (T_{i2} - T_{i1})}{h_1 T_{i2} + h_2 T_{i1}}$.

CASE V. TRANSFORMATION OF TWO MASSES OF DIFFERENT TEMPERATURES ON THE SAME LEVEL INTO A STATE OF EQUILIBRIUM.

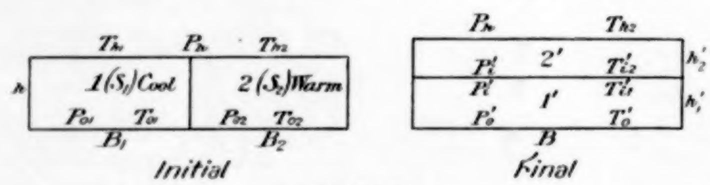

FIG. 24 C.

Given as data at the height h, T_{h1}, T_{h2} P_h, the areas B_1, B_2, the entropy $S_1 < S_2$. Hence by the formulas,

(36) $P_{01} = P_h\left(\frac{T_{01}}{T_{h1}}\right)^{\frac{nk}{k-1}} = P_h\left(1 + \frac{g h}{n C_p T_{h1}}\right)^{\frac{nk}{k-1}}$. $T_{01} = T_{h1}\left(1 + \frac{g h}{n C_p T_{h1}}\right)$.

(37) $P_{02} = P_h\left(\frac{T_{02}}{T_{h2}}\right)^{\frac{nk}{k-1}} = P_h\left(1 + \frac{g h}{n C_p T_{h2}}\right)^{\frac{nk}{k-1}}$. $T_{02} = T_{h2}\left(1 + \frac{g h}{n C_p T_{h2}}\right)$.

(38) Initial. $(V+U)_a = C_p\,\frac{1}{g}\,\frac{1}{1+\frac{k-1}{nk}}\,\frac{B}{2}(P_{01} T_{01} - P_h T_{h1} + P_{02} T_{02} - P_h T_{h2}) + \text{const.}$

(39) $P^1_i = P_h + \frac{1}{2}(P_{02} - P_h)$. $P^1_0 = P_h + \frac{1}{2}(P_{02} - P_h) + \frac{1}{2}(P_{01} - P_h)$.

(40) Final. $(V+U)_e = C_p\,\frac{1}{g}\,\frac{1}{1+\frac{k-1}{nk}}\,B(P^1_0 T^1_0 - P^1_i T^1_{i1} + P^1_i T^1_{i2} - P_h T_{h2}) + \text{const.}$

(41) Kinetic energy. $\frac{1}{2} M q^2 = (V+U)_a - (V+U)_e$.

(42) Mass and heights. $M = \frac{B}{g}(P^1_0 - P_h)$. $h^1_1 = \frac{C_p}{g}(T^1_0 - T^1_{i1})$. $h^1_2 = \frac{C_p}{g}(T^1_{i2} - T_{h2})$.

(43) Approximate solution for Case V. Take $\tau = \frac{T_2 - T_1}{T}$. $T^2 = T_1 T_2$. $M = B P_h \frac{h}{R T} = B \rho h$ (approximate).

(44) $$\tfrac{1}{2} M q^2 = \tfrac{1}{2} M \frac{B_1 B_2}{B^2} g h \tau.$$

CASE VI. CONTINUOUS HORIZONTAL TEMPERATURE DISTRIBUTION WITH ADIABATIC VERTICAL GRADIENT.

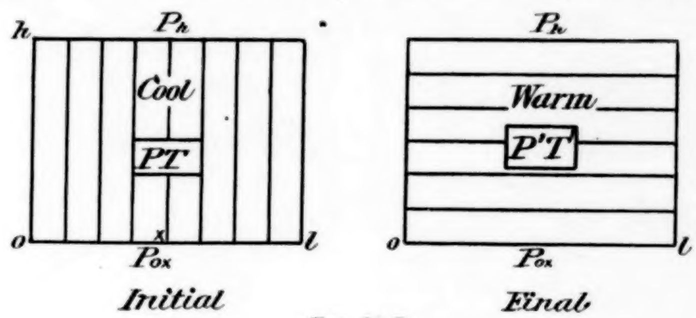

FIG. 24 D.

(45) Assume $$T = f(x) - \frac{g}{C_p} z.$$

(46) $$P^1 = P_h + \frac{1}{l} \int_{l-x}^{l} (P_{0x} - P_h)\, dx = P - \left[P - P_h - \frac{1}{l} \int_{l-x}^{l} (P_{0x} - P_h)\, dx \right].$$

(47) $$T - T^1 = T - T \left(\frac{P^1}{P} \right)^{\frac{k-1}{k}} = \frac{k-1}{k} \left(T - \frac{P_h}{R \rho} - \frac{1}{l R \rho} \int_{l-x}^{l} (P_{0x} - P_h) \right) d x.$$

(48) $$T_x \frac{P_{0x} - P_h}{g} = T_x \int_0^h \rho\, d z = \int_0^h T \rho\, d z.$$

(49) $$\int_0^h (T - T^1) \rho\, d z = \frac{k-1}{k} \frac{1}{g} P_h T_0 \left(\frac{gh}{R T_0} \right)^2 \left(\frac{1}{2} - \frac{x}{l} + \frac{\tau}{2} \frac{x}{l} - \frac{\tau}{2} \frac{x^2}{l^2} \right).$$

(50) $$\tfrac{1}{2} M q^2 = C_p \int_0^h (T - T^1)\, d m = l P_h \frac{gh}{R T_0} h \frac{\tau}{12}.$$

(51) $$q = \sqrt{\frac{g h \tau}{6}}.$$

CASE VII. POSITION OF LAYERS OF EQUAL ENTROPY WHEN THE PRESSURE AT A GIVEN LEVEL IS CONSTANT AND THE TEMPERATURE AT THIS LEVEL IS A FUNCTION OF THE HORIZONTAL DISTANCE AND A LINEAR FUNCTION OF THE HEIGHT.

Let the gradient ratio which distinguishes one stratification of the air from another having a different temperature gradient be n.

(52) $P = P_h \left(\frac{T}{T_h} \right)^{\frac{n C_p}{R}}$. $T = T_h + \frac{g}{n C_p} (h - z)$.

(53) The curves. $F(x z) = n \log T_h - (n-1) \log T = \text{const.}$

(54) Angle of curves. $\tan \alpha = \frac{\partial F}{\partial x} \Big/ \frac{\partial F}{\partial z} = \frac{n}{n-1} \left(\frac{h-z}{T_h} + \frac{C_p}{g} \right) \frac{\partial T_h}{\partial x}$.

CASE VIII. FINAL CONDITION OF TWO AIR MASSES UNDER CONSTANT PRESSURE WITH GIVEN INITIAL LINEAR VERTICAL TEMPERATURE FALL.

On removing the partition the layers 1 and 2 spread out, change their heights, and there is a mixed stratum between them.

(55) Temperatures $$\begin{cases} T_1 = T_{h_1} + \frac{g}{n_1 C_p} (h - z). \\ T_2 = T_{h_2} + \frac{g}{n_2 C_p} (h - z). \end{cases}$$

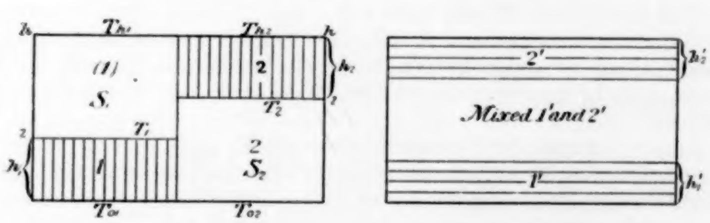

FIG. 24 E.

(56) Entropy $$\begin{cases} S_1 = C_p [n_1 \log T_{h_1} - (n_1 - 1) \log T_1] + \text{const.} \\ S_2 = C_p (n_2 \log T_{h_2} - (n_2 - 1) \log T_2) + \text{const.} \end{cases}$$

(57) $$\log \frac{T_{02}}{T_1} = \log \frac{T_2}{T_{h_1}} = \frac{n}{n-1} \log \frac{T_{h_2}}{T_{h_1}}.$$

(58) Heights $$\begin{cases} h_1 = \frac{n C_p}{g} (T_{01} - T_1). \\ h_2 = \frac{n C_p}{g} (T_2 - T_{h_2}). \end{cases}$$

If the vertical temperature fall of the masses 1 and 2 is smaller than in adiabatic equilibrium, then the entropy increases with the height, and it can happen that in the colder

mass (1) the entropy at the height h_1 will be as great as in the warmer mass (2) at the ground. The higher layers in (1) form a series with an entropy equal to the layers in (2) up to the height $h - h_2$. In the final state the under part of (1) will spread out on the ground, above it will be layers which are mixtures of (1) and (2), and farther up will lie the masses of (2) which initially were between $(h - h_2)$ and h. On the boundaries of the three layers the temperature transition is continuous.

It will be convenient to approach the dynamic equations of motion in cyclonic vortices thru a study of the Cottage City waterspout of August 19, 1896. It should be recognized that in ordinary cyclones the vortices are not perfect and it is only rarely and in highly developed storms that anything like pure vortex motion is attained. The waterspout, therefore, offers a good example of vortex motion in the atmosphere with which to test the above equations. I may remark that the theory first advanced in my International Cloud Report, 1898, for the generation of cyclones and anticyclones in the general circulation seems to be practically confirmed by these studies based upon actual observations.

VILLARD'S THEORY OF THE AURORA.

By WM. R. BLAIR, Assistant Physicist. Dated Mount Weather, Va., January 18, 1907.

In his "Essai de Théorie de l'Aurore Boréale",[1] M. P. Villard desires especially to account for the movements of the aurora and the various forms in which it appears. He assumes that the auroral light is due to the motion of cathode rays under the influence of the earth's magnetic field, and he argues that these rays are of terrestrial origin. The auroral arch, auroral draperies, and dance of the rays, as usually defined, are the peculiarities to be explained.

The earth's magnetic field is conceived to be similar to that existing between the poles of a Ruhmkorff electro-magnet (the coils being in line with each other). Using such a magnet and the theory, already developed, of how a cathode particle moves in a magnetic field, experiments were devised and carried out for the reproduction of the auroral phenomena on a small scale, in an evacuated bulb. Electrodes were sealed in the bulb; the negative electrode was especially devised for projecting into the field of the magnet, in a suitable direction, a small bundle of cathode rays. Photographs of these reproductions were obtained.

The first three of the following figures and their descriptions serve as a review of the effects of a magnetic field on the motion of projected cathode particles, the fourth, as a basis for the explanation of the forms and movements of the aurora.

Fig. 1 represents the earth's magnetic field. $A\ A'$ is the magnetic axis, N and S the poles. This field is such that the distribution of magnetic force in a plane thru $B\ B'$ and perpendicular to $A\ A'$ is symmetric with respect to the point at which the plane cuts the axis.

Fig. 2 shows the path followed by a cathode particle projected vertically into the earth's field in this equatorial plane, i. e., at right-angles to the line of force. The curve traced is an epitrochoid.

Fig. 3 illustrates the motion of an electron in a uniform magnetic field. Its path is a helix lying lengthwise in the direction of the field. In this case the electron entered the field in a direction other than at right-angles to the lines of force.

The more general case in which the magnetic field is not uniform, but, like that of the earth, has converging lines of force, can not be readily represented by means of a diagram. It will be explained by the use of figs. 2 and 3. The electron is projected into the magnetic field at an angle to the equatorial plane, and consequently its path is a combination of the helical and epitrochoidal paths with this additional feature. In the increasing field the successive spires of the helix, according to Villard, decrease in diameter and in forward

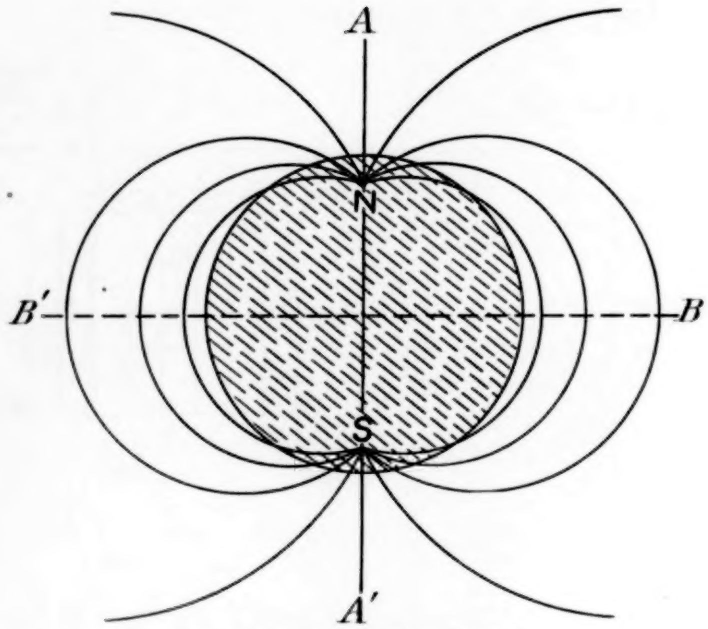

FIG. 1.—The earth's magnetic field.

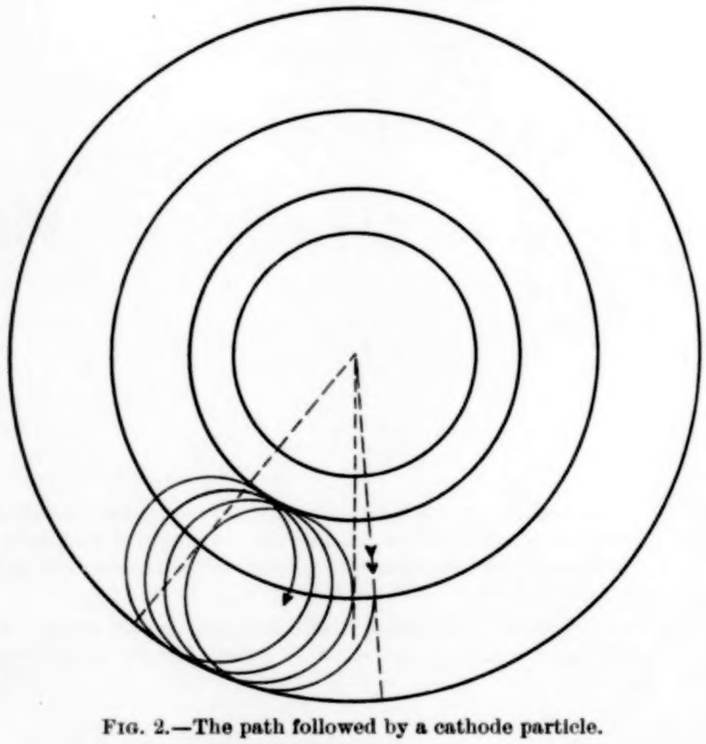
FIG. 2.—The path followed by a cathode particle.

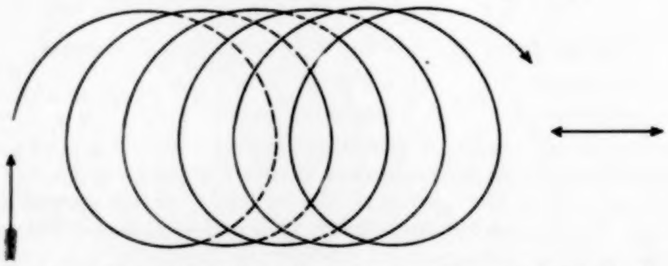
FIG. 3.—The motion of an electron in a uniform magnetic field.

[1] Annales de Chimie et de Physique, September, 1906.

velocity, this forward velocity becoming zero and then negative. With the increase in velocity in the negative direction, the diameters of the spires increase. The electron is thus a prisoner of the magnetic field traveling back and forth between the poles but never reaching either one.

The zigzag path of a cloud of electrons, distorted to fit a plane surface, is shown in fig. 4. Imagine this figure on the surface of a sphere. The lines marked north pole and south pole become points. The reenforced parts, due to the overlapping of the paths, occur along magnetic meridians and the turning points of these paths lie on magnetic parallels.

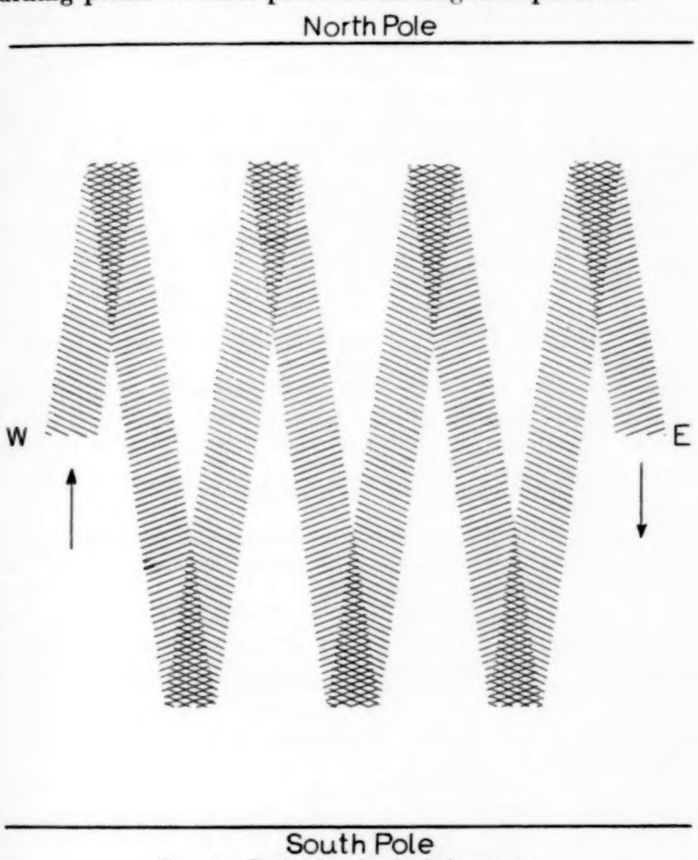

FIG. 4.—Path of a cloud of electrons.

In the glass bulb in which the artificial aurora was produced it was found that where the paths overlapt the light was decidedly more intense. These regions correspond to the auroral rays, which are observed to be parallel to a free magnetic needle. Since these rays terminate on the same magnetic parallel, we have the auroral arch. If the distance between homologous points of two neighboring rays is greater than the width of a ray, we have the fan-shaped aurora; if less, the auroral drapery. The aurora in the north must always be accompanied by one in the south.

The general motion of a cloud of electrons is from west to east (consider fig. 2). The rate of this easterly motion is, for a given magnetic field, a function of the intensity of the electric field, i. e., of the velocity of the electrons. Corresponding to variations of the electric field we shall have, consequently, the rotation of the aurora, to the west in an increasing field, to the east in a decreasing field. Since the distance from the poles of the turning points in the paths of the electrons is a function of the magnetic field strength, variations in this field will cause the north and south motions, the dancing of the rays. This motion will be away from the pole in an increasing field and toward it when the field is decreasing. The artificial dance of the rays was produced by bringing a small bar of iron near one of the poles of the Ruhmkorff magnet, thus causing variations in the field strength.

The chief argument for terrestrial as opposed to solar origin of the cathode rays is the fact that auroras, at altitudes of some hundreds of kilometers from the earth, are sometimes seen as far south as the equator. Admitting that electrons can get away from the sun, those that reach the earth must approach and recede along the almost vertical magnetic lines in the immediate vicinity of the poles of the earth's field, producing an aurora which if visible at all in the lower latitudes would necessarily occur at very high altitudes. The supposed source of the electrons is a cloud under the influence of solar radiation. Other possible sources are mentioned. Since these can occur only on that side of the earth next to the sun, and since the comparatively feeble light of the aurora is not visible until after sunset, more and brighter auroras are seen just after dark than later in the night, the easterly auroral rays being always feebler than those toward the west.

The following articles present a theory also based on the motion of cathode rays in the earth's magnetic field; the chief differences between these theories being that in the latter the sun is the source of the cathode rays.

Notes de M. Carl Störmer.—Sur les trajectoires des corpuscules électriques dans l'espace sous l'influence du magnétisme terrestre, avec application aux aurores boréales et aux perturbations magnétiques. Comptes Rendus, 25 Juin, 1906; 9 Juillet, 1906; et 1 Octobre, 1906.

Note de M. Carl Störmer.—Les expériences de M. Villard et sa théorie des aurores boreáles. Comptes Rendus, 10 Septembre, 1906. This note contains reference to the previous work of Störmer and to the work of Birkeland, to whom is due the hypothesis that the aurora is caused by the motion, under the influence of the earth's magnetic field, of cathode particles which have been projected from the sun.

Note de M. P. Villard.—Sur l'aurore boréale: Réponse à la Note de M. Störmer. Comptes Rendus, 22 Octobre, 1906.

For the purpose of comparing these theories with actual observations, the papers by Prof. Cleveland Abbe, in "Terrestrial Magnetism", March, June, and December, 1898, and a paper by Doctor Chree, in "The Philosophical Magazine", January, 1907, will be found interesting. The first of these treats of the altitude of the aurora; the second compares sunspot and auroral frequencies.

OBSERVATIONS OF HALOS IN ENGLAND.

By M. E. T. GHEURY. Dated Eltham, Kent, January 2, 1907.

My observations of halos have been but casual, and but few were actually recorded; I have always, however, expected wet weather after a solar or a lunar halo. On perusal of my notes, I find but the following records:

(1) London, 15th of December, 1902, 11 p. m., halo of 22° (moon), rather pale, but better defined and plainly visible in its upper half. Rain fell during the whole of the 16th.

(2) Chelmsford (Essex), 4th of October, 1903, 10 p. m., halo of 22° (moon), well defined. Abundant rain the morning of the 5th.

(3) Chelmsford (Essex), 3d of November, 1903, 10 p. m., halo of 22° (moon), well defined. No mention of following weather. A reference to my private diary, however, leads me to believe the next day was rainy.

(4) Chelmsford (Essex), 1st of February, 1904, 10 p. m., halo of 22° (moon), well defined. No mention of following weather, but a similar reference allows me to infer that the next day was gloomy, threatening rain.

(5) Chelmsford (Essex), 30th of December, 1906, noon, halo of 22° (sun), 2 parhelia and adjacent fragments of horizontal circle. I would have expected rain but for the fact that after a night of frost, and a light thaw in the morning, it was beginning to freeze hard again. Nevertheless, *it rained* that evening from 7:30 p. m. until about 9:00 p. m.

PROBLEMS IN METEOROLOGY.

By C. F. VON HERRMANN, Section Director. Dated Baltimore, Md., June 9, 1906.

The use of mathematics in meteorology has often been discust, either with reference to the application of methods of higher analysis to the solution of the intricate problems presented by the dynamics of the atmosphere, or to the introduction of problems in meteorology as illustrative examples in courses of higher mathematics. Even in elementary work, however, for purposes of serious instruction in meteorology, in which many officials of the Weather Bureau are now engaged, precision and dignity would be given to a course by the introduction, as laboratory work, in addition to the usual exercises in map making, etc., of examples requiring only elementary mathematics for their solution. What student could forget that the coefficient of expansion of air is 0.00367 or 1/273, if he were required to calculate the weight of a cubic meter of air at different temperatures? Or who could forget that the adiabatic rate of decrease of temperature with elevation for dry air is 1° C. for 100 meters, if he has been taught, by simple mathematical analysis, how the result is obtained? Those who are carrying on courses of instruction in meteorology (in distinction from popular lecture work) will find that the use of numerous examples will greatly stimulate the interest of the student, and help to elevate the subject to the rank of an exact science.

Unfortunately there are no text-books of elementary meteorology which give examples for solution. In Ferrel's "Recent advances in meteorology", Annual Report of the Chief Signal Officer for 1885, numerous examples are given, but they are generally too advanced for elementary work, tho many of them may readily be simplified. For the purpose suggested a number of examples have been collected, requiring only the elements of algebra and trigonometry for their solution; these are stated below. It is advantageous in all problems to use the centigrade degree, the metric system of measurements, and as the unit of heat the small calorie, which is more definite than the British thermal unit. The solutions are stated in the most elementary language, but more advanced problems will follow if these are favorably received.

Problem 1.—Calculate the mass of the atmosphere.

Solution.—If the atmosphere had the same density thruout which it has under the standard conditions ordinarily adopted (pressure 760 mm., temperature 0° C., and latitude 45°), its height would be 7991 meters (h), which is the height of a homogeneous atmosphere of air. One cubic meter of air of that density weighs 1.29305 kilograms.

From geometry, the volume of a sphere is $4/3\,\pi R^3$, in which π is 3.1416, and R the mean radius of the earth in meters or 6370191 meters (Bigelow).

The volume of the earth including the atmosphere, less the volume of the earth alone, will give the volume of the atmosphere in cubic meters, or $4/3\,\pi(R+h)^3 - 4/3\,\pi R^3$ equals volume of atmosphere in cubic meters.

Factoring: $4/3\,\pi(3hR^2 + 3h^2R + h^3)$, or $4/3 \times 3.1416\,(3 \times 7991 \times 6370191^2 + 3 \times 7991^2 \times 6370191 + 7991^3)$, which is equal to 4080×10^{15} cubic meters.

Since 1 cubic meter of air weighs 1.293 kilograms, then the weight of the atmosphere is $4080 \times 10^{15} \times 1.293$, or $5{,}275.46 \times 10^{15}$ kilograms.

This is $\frac{1}{1125000}$ of the mass of the solid earth. (MONTHLY WEATHER REVIEW, February, 1899, page 58–59.)[1]

[1] The figures in Monthly Weather Review, Vol. XXVII, p. 59, require the following corrections: For 198,940,000 read 196,940,000 square miles; for 10,392 read 11,602; for 1/1,125,000 read 1/1,132,400. The mass of the atmosphere would, therefore, be $11{,}602 \times 10^{15}$ pounds, or $5{,}263 \times 10^{15}$ kilograms. The difference between this older computation and that in the above text is traceable to the differences in the assumed data, some of which are slightly uncertain.—EDITOR.

The weight of the atmosphere, found in the manner above described, is somewhat greater than the result found in the MONTHLY WEATHER REVIEW, February, 1899, because the mean barometric pressure is here assumed to be 760 millimeters or 29.92 inches, instead of 29.90 inches.

According to Hann, Lehrbuch, second edition, page 9, if the heights of the continents are taken into consideration, the normal pressure would reduce to 740 millimeters (homogeneous atmosphere 7790 meters), but this should be increased about 0.48 per cent for the decrease of gravity with elevation (giving homogeneous atmosphere of 7827 meters); with this figure the mass of the atmosphere is 5200×10^{15} kilograms.

Problem 2.—The density of hydrogen is 0.0696; calculate the height of a homogeneous atmosphere of hydrogen.

Solution.—Let the standard atmospheric pressure, or height of the mercurial column in centimeters, be 76.

Let the density of mercury, or the weight of a cubic centimeter in grams, be 13.596 (Regnault).

Let the relative density of hydrogen, that of air being 1, at temperature 0°C and under standard pressure, be 0.0696.

Let the density of air under standard conditions, or the weight of a cubic centimeter in grams, be 0.001293.

Then 0.001293×0.0696 is the weight of a cubic centimeter of hydrogen, i. e., 0.00008993 grams.

Since the height of a column of gas of uniform density and the height of the mercurial column are inversely as the densities, we have the height of a homogeneous column of hydrogen,

$$\frac{76 \times 13.596}{0.00008993} = 11{,}481{,}066 \text{ centimeters or } 114{,}811 \text{ meters.}$$

For air, the weight of a cubic centimeter is 0.001293; so that the height of a homogeneous atmosphere of air is

$$\frac{76 \times 13.596}{0.001293} = 7991.04 \text{ meters.}$$

	Density.		Meters.
Nitrogen	0.96737	homogeneous atmosphere	8,261.
Oxygen	1.10535	homogeneous atmosphere	7,229.
Argon	1.37752	homogeneous atmosphere	5,801.
Carbon dioxid..	1.5291	homogeneous atmosphere	5,226.
Helium	0.1406	homogeneous atmosphere	56,834.
Aqueous vapor..	0.622	homogeneous atmosphere	12,847.

Problem 3.—The twilight arch disappears when the sun is 18° below the western horizon; calculate the height of the atmosphere.

Solution.—See fig. 1. At the moment when twilight ceases, the last visible particle of air will be just halfway between the observer and the point nearest the sun where it is just setting.

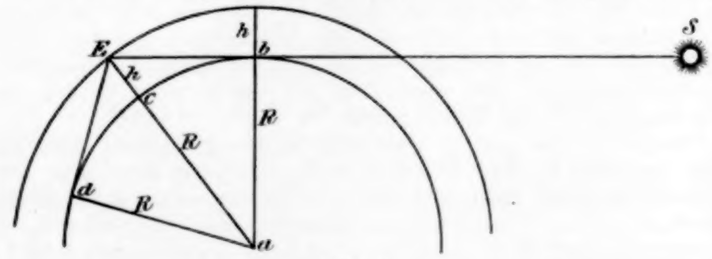

FIG. 1.

Therefore, the arc bc is equal to the arc cd. The whole arc bd is 18°; therefore, half the arc is 9°.

Calling the height of the atmosphere h, and the radius of the earth R, we have from the right-angled triangle abe, by simple definition in trigonometry, ae/ab is the secant of bae.

$$ae = ab \times \text{secant } bae.$$

Since $ae = R + h$, and $ab = R$ we have

$$R + h = R \times \text{secant } 9^\circ$$

$$h = R \text{ secant } 9^\circ - R = R\,(\text{secant } 9^\circ - 1).$$

Secant 9° is 1.0125; therefore, the last expression reduces to

$$h = 0.0125\ R.$$

In which $R = 6,370,191$ meters or 20,899,600 feet.[2]
$6370191 \times 0.0125 = 79627.4$ meters or 80 kilometers—about 50 miles.

This must be reduced by about 1/5 on account of refraction, making the height of the atmosphere about 40 miles. See Young's General Astronomy, 1889, pages 68–69.

Problem 4.—From the known rate of increase of temperature with increasing depth in the earth's crust, calculate the heat annually received at the surface and the thickness of ice which it will melt.

Solution.—The calculation of the heat received from the interior is made by multiplying the temperature gradient by the average thermal conductivity of the soil. This latter is about 0.006 gram-calories per square centimeter per second. The gradient is 1° C. for 35 meters, or 0.000286° C. for each centimeter. This multiplied by 0.006 gives the amount of heat received per second on each square centimeter of the earth's surface from the internal heat. It is equal to 0.000001716 gram-calories.

As the year has 31,556,926 seconds,[3] the amount of heat received per year on each square centimeter is $0.000001716 \times 31,556,926$, or 54.2 gram-calories.

The thickness of ice melted or water evaporated by 54.2 calories is based on the number of heat units required to melt a cubic centimeter of ice or evaporate a cubic centimeter (gram) of water.

The latent heat of fusion of ice is 80.02 calories, which is the amount of heat required to melt 1 gram. A cubic centimeter of ice, however, only weighs 0.917 gram, and to melt it requires only 80×0.917, or 73.4 calories.

Then the heat received per annum per square centimeter from the interior, or 54.2 calories, will melt only 54.2/73.4 or 0.74 cubic centimeters of ice, i. e., a piece one centimeter square and only 7 millimeters thick.

The latent heat of vaporization of water is in round numbers about 600 calories, so 54.2 calories would evaporate only 54.2/600 or about 0.09 grams of water per annum. See Hann, Lehrbuch der Meteorologie, first edition, page 23.

Problem 5.—Given, in certain cases, the temperature gradient in the soil and its conductivity, calculate the amount of heat transmitted to the air, and how much the air may be warmed thereby.

Solution.—At Tiflis in January the mean temperature of the soil at a depth of 0.1 meter is 1.1° C.; at 0.2 meters it is 1.6° C., and at 0.4 meters it is 2.9° C. Therefore the temperature increases with depth at the rate of 2.5° C. per 40 centimeters, or 0.06 °C. per centimeter.

The calorimetric conductivity of the soil, i. e., the quantity of heat in calories which will pass in one second thru a centimeter cube when the difference in temperature of the two faces is 1° C., is 0.006; this gives 0.36 calories per minute.

The amount of heat conducted to the surface by the soil is equal to the temperature gradient, multiplied by the conductivity of the soil, multiplied by the time.

For the case given: $0.36 \times 0.06 \times 1440$, which is equal to 31.1 calories per day.

The specific heat of air is 0.238 calories, i. e., one gram of air requires 0.238 calories to increase its temperature 1° C. One cubic centimeter of air weighs only 0.001293 grams, and requires, therefore, only 0.001293×0.238, or 0.000307 calories to raise its temperature 1° C.

Therefore the heat given to the air per square centimeter in this case would raise the temperature of 31.1/0.000307, or approximately 100,000 cubic centimeters of air, by 1° C. in one day—provided it were all absorbed by the air and not lost by radiation. This is equivalent to a horizontal layer one kilometer deep. See Hann, Lehrbuch, page 85.

Problem 6.—Calculate the heat received annually by the entire earth, assuming the solar constant to be 3 calories per square centimeter per minute.

Solution.—The solar constant 3 means that each square centimeter would receive per minute 3 small calories of heat, if there were no atmosphere, assuming the receiving surface to be perpendicular to the sunbeam.

The amount received per square centimeter per annum would evidently be 3×60 (minutes) $\times 24$ (hours) $\times 365\frac{1}{4}$ (days) $= 1,577,880$ calories.

Since the sun shines at one time on only one-half of the earth, its rays are perpendicular over an area represented by the area of a great circle or πR^2. Hence the above figure must be multiplied by $6,370,191 \times 6,370,191 \times 3.1416$, which gives $20,116 \times 10^{16}$ gram calories. See Hann, Lehrbuch, first edition, page 26. The amount there given is $20,116 \times 10^{20}$, possibly a typographical mistake for 2.0116×10^{20}.

The amount of ice which this will melt may be ascertained easily, as follows: Three calories per square centimeter per minute are 180 calories per hour. This would melt 180/73.4 or 2.45 cubic centimeters of ice in an hour. In a year, therefore, $2.45 \times 24 \times 365\frac{1}{4}$ or 21,476.7 cubic centimeters of ice would be melted for each square centimeter of surface. If the heat were uniformly distributed over the earth's surface it would cover 4 great circles, hence the above figure must be divided by 4, which gives a depth of about 5370 cubic centimeters of ice, or 54 meters or 177 feet per year.

Problem 7.—Prove that the intensity of insolation varies as the sine of the angle of incidence of the sun's rays.

Solution.—See fig. 2. The surface $A'\ B$ receives less insolation in proportion as this surface is larger than the surface $C'\ B$ at right-angles to the pencil of rays S. The intensity (I') of the insolation on $A'\ B$ is to the intensity (I) on $C'\ B$ inversely as the lengths of those lines, or

[2] A sphere whose surface has the same area as Clarke's spheroid of 1866 (whose $a = 20,926,062$ and $b = 20,855,121$ feet) would have $R = 20,902,490$ feet. Its surface would be 196,940,000 square miles. (See Woodward, Smithsonian Geographical Tables, 1894). Not only the dimensions of the globe but the relation between the meter and the foot have been subject to numerous investigations, and the results as given by different geodesists are gradually becoming more reliable. Besides the above-given values by Clarke, the following values may be mentioned:

Bessel, 1842, $a = 6,377,397$ and $b = 6,356,079$ meters.
Fischer, 1868, $a = 6,378,238$ and $b = 6,356,230$ meters.
Faye, 1889, $a = 6,378,393$ and $b = 6,356,549$ meters.

The mean radius of the earth may be described as the radius of a perfect sphere whose surface is equal to that of the spheroidal earth, or again, that of a sphere whose volume is equal to that of the earth, or again, that of a sphere whose radius is the average of all terrestrial radii. These three values differ slightly among themselves. The first value is that above given in connection with Clarke's spheroid. The International Meteorological Tables of 1900 adopt the a and b of Bessel's spheroid, and the mean radius R equals 6,371,104 meters, equals 20,902,950 English feet. The values of a and b adopted in Bigelow's Cloud Report are those of Bessel's spheroid, and the average R equals 6,370,191 meters, equals 20,899,600 feet.

The relation between the meter and the English foot adopted by the International Meteorological Tables, namely, 1 meter equals 3.28089917 feet, or 1 foot equals 0.30479449 meter, was Kater's value of 1818; it has lately been more accurately determined (see Monthly Weather Review for December, 1896); namely, 1 meter equals 3.2808429 feet, and 1 foot equals 0.30479973 meter. All these refinements in decimals imply equal refinements in definitions and other matters that are still under discussion, and need not trouble the elementary student, who should for consistency's sake use either the system adopted by the International Meteorological Tables or that adopted by Professor Bigelow, or that adopted by the International Bureau of Weights and Measures.—EDITOR.

[3] According to S. Newcomb, Compendium of Spherical Astronomy, 1906, p. 393, the Julian year has 31,557,600, but the correct mean solar year has 31,556,926.0 seconds.—EDITOR.

$$I' : I :: C' B : A' B.$$
$$I' = I(C' B \,|\, A' B)$$

$C' B \,|\, A' B$ is the cosine of $90° - h$, or the sine of h, which is the angle of incidence of the sun's rays to the horizontal surface, or the angular elevation of the sun above the horizon.

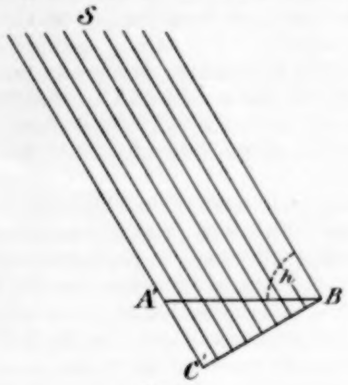

FIG. 2.

By this method the intensity is decomposed after the manner of a force in mechanics, as first proposed by Halley in 1693; the same law may be obtained in an entirely different way from the principle of the inverse square of the distance. See Meech, L. W., On the Relative Intensity of the Heat and Light of the Sun, upon Different Latitudes of the Earth, 1856, pp. 13, 14.

Problem 8.—Given the coefficients of expansion of brass and mercury, deduce the corrections to be applied for the temperature of the scale and of the mercury in a mercurial barometer.

Solution: (Metric system).—1. As the brass scale divisions and their numbers rise with increase of temperature, at any temperature above freezing (where the scale has its standard length), opposite a fixed point, the scale reading would be too low or the length of the scale would be too great.

Let n be the coefficient of linear expansion of brass; then unit length of the scale at 0° is 1; at 1° C. it becomes $1 + n$; at 2° it becomes $1 + 2n$, or in general at $t°$ it bec omes $1 + tn$

2. If B is the mercurial column (barometric height) as measured with the scale at a temperature $t°$, then the height as measured with the scale at the temperature 0° would be greater, since the length of each division would then be less, in the ratio of 1 to $1 + tn$, so that the number of divisions corresponding to a given length will be increased in the ratio $(1 + tn)$ to 1. Hence, if B_n is the barometer reading corrected for the expansion of the scale, then

$$B_n = B\,(1 + tn) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

See Watson's Physics, page 159.

3. Here B_n is the height of the mercurial column at the temperature $t°$, and we have to find what would be the height if the temperature of the mercury were 0°.

If D_t is the density of mercury at $t°$, and D_0 its density at 0°, and m the coefficient of expansion of mercury, then 1 cubic meter of mercury at 0° becomes $(1 + m)$ cubic meters at 1°, $(1 + 2m)$ cubic meters at 2°, or in general $(1 + tm)$ cubic meters at $t°$. Or if V_0 is the volume at 0° and V_t the volume at $t°$, $V_t = V_0\,(1 + tm)$.

Since the mass of the mercury remains the same, the volume at 0°, V_0, multiplied by the density of mercury at 0°, D_0, i. e., the mass, M, must equal the volume at $t°$, V_t, multiplied by the density at $t°$, D_t.

Substituting for V_t its value $(1 + tm)\,V_0$ gives

$$M = V_0\,D_0 = V_t\,D_t = (1 + tm)\;V_0\,D_t.$$
$$V_0\,D_0 = (1 + tm)\;V_0\,D_t.$$
$$D_0 = (1 + tm)\;D_t.$$
$$\frac{D_t}{D_0} = \frac{1}{(1 + tm)}.$$

The height of a column of mercury supported by a given pressure being inversely proportional to the density of the liquid, therefore

B_n (height of mercurial column at $t°$) : B_0 (height at 0°) :: D_0 (density of mercury at 0°) : D_t (density of mercury at $t°$), from which

$$\frac{B_0}{B_n} = \frac{D_t}{D_0} = \frac{1}{(1 + tm)} \qquad B_0 = \frac{B_n}{(1 + tm)} \quad \ldots\ldots\ldots (2)$$

Substituting in equation (2) the value for B_n found by equation (1), gives

$$B_0 = \frac{B\,(1 + nt)}{(1 + mt)}.$$

Dividing by $(1 + mt)$ gives

$$B_0 = B\left(1 - \frac{(m - n)\,t}{(1 + mt)}\right); \text{ or } B_0 - B = -\frac{(m - n)\,t}{(1 + mt)}\,B.$$

See equation (17), Bigelow's Report on Barometry, page 62.

The coefficient of expansion of brass for 1° C. is 0.0000184, or approximately 0.00002. For mercury, $m = 0.0001818$.

By assuming that $1/(1 + mt)$ is equal to $(1 - mt)$, which can be done, as the higher powers of m are very small, the above equation will approximate

$$B_0 = B\left(1 - (m - n)\;t\right),$$

or substituting the constants, $B_0 = B\,(1 - 0.000163\;t)$. The correction is very closely $-0.000163\,tB$. See Hann, Lehrbuch, page 164.

Example.—Observed reading of the barometer 745.6 millimeters at a temperature of 25° C. Corrected reading will be found by subtracting $0.000163 \times 25 \times 745.6$, or 3.05 millimeters, which corresponds closely with the correction found from the usual tables.

Problem 9.—Obtain the formula in the English system for the correction of the mercurial barometer for temperature.

In obtaining the formula for the English system it must be remembered that the brass scale is normal at 62° F. and the mercury has its normal density at 32° F. The equations in solution of problem 8 may readily be modified accordingly. See Abbe, Treatise on Meteorological Apparatus and Methods, 1887.[4]

Problem 10.—From well known physical relations deduce the law that ascending dry air cools 1° C for each 100 meters of ascent.

Solution.—It is necessary to know the following data:

1. The unit of heat, the small calorie, is the amount required to raise the temperature of 1 gram of pure water 1° C. Engineers use a large calorie, which is the amount of heat required to raise 1 kilogram of water 1° C.; this is 1000 times the small calorie.[5]

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[4] Where the formulas are:

$$B' = B\;[1 + \beta\,(t - 62)\,]$$
$$H_0 = \frac{B'}{1 + \gamma\,(t - 32)}$$
$$H_0 - h = H_0 - B'' = B'\left(\frac{1 + \beta\,(t - 62)}{1 + \gamma\,(t - 32)}\right) - B''$$
$$= B''\left(\frac{\beta\,(t - 62) - \gamma\,(t - 32)}{1 + \gamma\,(t - 32)}\right)$$

From Report of the Chief Signal Officer, 1887, part 2, pp. 124-126.

The notation can be easily understood by comparing these formulas with those of Problem 8.

If the temperatures of the mercury and the brass scale are not identical then the corrections for each must be calculated separately, or may be taken from the tables given on pages 1133-1137 of Appendix 59, Report of the Chief Signal Officer, for 1881.—EDITOR.

[5] As the specific heat of water varies with its temperature it is necessary to define a calorie more exactly. The practise among European physicists is to define the small calorie as the quantity of heat necessary to raise the temperature of a gram of water from 0° C. to 1° C.—EDITOR.

2. Work is the product of the force acting multiplied by the space thru which it acts.

3. By actual experiment it is found that the energy which would raise the temperature of 1 kilogram of water 1° C. would be able to raise against gravity 1 kilogram to the height 426.8 meters. (See Bigelow, Cloud Report, p. 488.) This is the mechanical equivalent of a unit of heat, or the work done by it. Standard gravity at sea level and 45° latitude is the value here used.

4. To raise the temperature of 1 kilogram of air 1° C. under constant pressure requires 0.2374 of a large calorie. This is the specific heat of air under constant pressure, and is found also by experiment.

5. Since 1 cubic meter of air weighs 1.293 kilograms, therefore the amount of heat required to raise the temperature of 1 cubic meter of air 1° C. is a little more than 0.2374 of a unit; it is evidently 0.2374 × 1.293 or 0.307 of a large calorie.

Apply heat to a cubic meter of air and allow it to expand in one direction while the pressure is kept constant. The amount of heat required to raise the temperature of the cubic meter of air 1° C. is 0.307 unit of heat. The air will at the same time be expanded 1/273 of its volume.

The resistance to be overcome by the expanding air is the pressure of a standard atmosphere on a square meter, which is 0.76 × 13,596, or 10,333 kilograms per square meter. The space thru which the resistance is overcome is 1/273 of a meter; thus the work done by the expanding air against the pressure of the atmosphere is 10,333 × 1/273 or 37.85 kilogram-meters.

If the amount of work performed by the 0.307 unit of heat which is used to expand the air be 37.85 kilogram-meters, then 1 entire unit of heat so employed to the expansion of air would do an amount of work, x, as given by the proportion

$$0.307 : 37.85 :: 1.000 : x$$
$$x = 123.28 \text{ kilogram-meters.}$$

But by paragraph 3 the whole work equivalent of 1 unit of heat is 426.8 kilogram-meters. Therefore the fraction of a heat unit doing the expansive work required when 1 cubic meter of air is heated 1° C. is to the whole unit as 123.28 to 426.8, or as 0.289 to 1. In general when a given amount of heat acts on dry air the fractional part 0.711 goes toward heating the air, and the remaining 0.289 is used in doing the work of expansion against the outside pressure of 760 millimeters.

On the other hand, if air is caused to expand by coming under diminished pressure without the addition of any heat from without, i. e., adiabatically, then in expanding 1/273 of its volume, it will require 0.289 part of a heat unit for the work. The expansion will be done at the expense of its own heat, and the air will be cooled 0.289° C. by an expansion of 1/273 part.

If the air cools 0.289° in expanding 1/273 part, then to cool 1 whole degree the air must expand x parts, as given by the proportion

$$0.289 : 1/273 :: 1 : x$$
$$x = 1/79$$

A homogeneous atmosphere would have a height of 7991 meters. If in such a homogeneous atmosphere the air ascends 1 meter the pressure would be diminished 1/7991 part, and the volume would expand 1/7991 part. Then in order to increase the volume 1/79 part (and cool the air 1°C.) the air must ascend x meters, as given by the proportion

$$1 : 1/7991 :: x : 1/79$$
$$x = 7991/79 \text{ or } 101.2 \text{ meters.}$$

Thus we see that air must ascend 101.2 meters to cool 1° C. This is 0.99° for 100 meters, or as frequently stated in round numbers 1° C for 100 meters.

This is hardly a problem, as the matter is simply reasoned out. By the use of the elements of calculus the problem is much more elegantly solved. See Ferrel's Treatise on Winds, pages 23 to 28.

Problem 11.—Deduce the simplest formula for expressing the change of pressure with elevation in the atmosphere.

Solution.—The solution of this problem requires the use of the very simplest elements of calculus, which any student can readily grasp, even if not previously familiar with the subject.

1. Let v represent the volume of a given mass of air or gas at the pressure p and temperature t; and v^1 its volume, p^1 its pressure, and t^1 its temperature under standard conditions; then, since the coefficient of expansion of air is a, 1 cubic meter at zero becomes $(1 + a)$ cubic meters at 1° C., $(1 + 2a)$ cubic meters at 2°, and in general $(1 + at)$ cubic meters at t. By the law of Boyle-Gay Lussac, the volume of a gas multiplied by its pressure is constant, so that

$$p\,v = p^1 v^1 (1 + a t) \qquad (1)$$

Substituting for a its value 1/273, we have

$$p\,v = \frac{p^1 v^1 (273 + t)}{273} = \frac{p^1 v^1}{273}(273 + t).$$

Now, $(273 + t)$ is called the absolute temperature, or T, and $p^1 v^1/273$ is called the gas constant, R.

$$\text{Therefore, } p\,v = R\,T \qquad (2)$$

2. Next find the numerical value of $R\,T$ for dry air.

The volume of gas is the reciprocal of its density; or if one cubic meter of air weighs 1.293 kilograms, then 1 kilogram will occupy 1/1.293 cubic meters of space. Calling D^1 the density of air, weight of unit volume, at 760 mm., at 0° C, then

$$v^1 = 1/D^1, \text{ or } D^1 = 1/v^1 \qquad (3)$$

Therefore, $p^1 v^1 = 1/D^1 \times p^1$, and p^1 equals the normal pressure, that is the density of mercury multiplied by the normal height of the barometer, or

$$p^1 v^1 = \frac{13.596 \times 0.760}{0.001293} = 7991.$$

This is evidently equal to the height in meters of a homogeneous atmosphere of air, or 7991.

Therefore, $p^1 v^1/273$, the gas constant for dry air, or R, is equal to

$$\frac{13.596 \times 0.760}{0.001293 \times 273} = 29.2713.$$

3. In ascending a very small distance (infinitesimal distance) in the atmosphere, in which the density is D_0, the absolute pressure changes in the inverse proportion by an infinitesimally small amount; this is exprest in the notation of calculus as follows:

$$-d\,p = D_0\,dh.$$

From (2) and (3), $p\,v = R\,T$, and $D_0 = 1/v$; $v = R\,T/p$; $D_0 = p/R\,T$.

Substituting, $-d\,p = p/R\,T\,(d\,h)$, or

$$-\frac{d\,p}{p} = \frac{d\,h}{R\,T}$$

From which follows by integration

$$\log_n p = \log_n p^1 - h/R\,T \qquad (4)$$

in natural logarithms.

4. Instead of the absolute pressure p and p^1, we may introduce the barometric heights, b and B_n (normal pressure), which gives:

$$\log_n b = \log_n B_n - h/7991 \qquad (5)$$

5. To reduce to ordinary logarithms, divide the denominator, 7991, by the modulus, 0.43429, giving 18,400, the so-called barometric constant for air, giving final answer to the problem:

$$\log b = \log B_n - h/18{,}400 \qquad (6)$$

Numerical example.—What is the pressure at an elevation of 10 kilometers when sea-level pressure is 760 millimeters and temperature is 0° C.?

$\log b = \log 760 - 10{,}000/18{,}400$
$\log b = 2.88081 - 0.5435$
$\log b = 2.33731$, which corresponds to 217 millimeters.

The student should be required to work out a table of barometric pressures for a series of elevations.

6. From the above the additional problem is suggested of finding the simplest formula for calculating the altitude of a place, if the mean temperature of the air column and the pressures at the two stations are known.

By transposing (6) and introducing a temperature factor we have $h = 18{,}400\,(1 + \alpha t) \log (B_n/b)$ the simplest hypsometrical formula. See Hann, Lehrbuch, page 168.

Problem 12.—Give a formula expressing the weight of a cubic meter of dry air under varying temperature and pressure.

Solution.—Call the standard density D_0. A cubic meter of air under standard conditions (temperature 0° C., pressure 760 millimeters, and latitude 45°) weighs 1.29305 kilograms, or 1293.05 grams. The density of air diminishes as the temperature rises in the proportion of 1 to $1 + \alpha t$; it also diminishes as the pressure decreases, for the air expands in proportion, or as b to 760. Therefore the density of air under other conditions is equal to its density under standard conditions, D_0, multiplied by

$$\frac{1}{1+\alpha t} \times \frac{b}{760};$$

or the weight in grams of a cubic meter of air at $t°$ C. and pressure b is equal to

$$\frac{D_0\, b}{(1+\alpha t)\, 760} = \frac{1293.05}{1+\alpha t} \times \frac{b}{760} \; \ldots\ldots\ldots\ldots\ldots \; (1)$$

Example.—What is the weight of a cubic meter of air under 760 millimeters pressure at the temperature of 30° C?

$\alpha = 0.00367$. Then,

$$\frac{1293.05}{1 + 0.00367 \times 30} \times \frac{760}{760} = \frac{1293.05}{1.1101} = 1164.9 \text{ grams.}$$

If we call the weight of a cubic meter of air at 0° unity, then at 30° C. the weight of a cubic meter will be 0.9008 of unity.

If 1 cubic meter of air at 30° weighs 0.9008 of what it does at zero, then it will require 1/0.9008 cubic meters at 30° to weigh as much as 1 cubic meter at zero, or 1.1101.

The student should be required to calculate for every 5° of temperature between −30° and 30° C. the weight of a cubic meter in grams, the density when 1 cubic meter at 0° weighs unity, and the volume whose weight equals that of 1 cubic meter at 0°—arranging the data in the form of a table, thus:

Temperature.	Weight of a cubic meter.	Density when 1 cubic meter at 0° weighs 1.	Volume which weighs the same as 1 cubic meter at 0°.
°C. 30	*Grams.* 1164.9	0.9008	*Cubic meters.* 1.1101

See Hann, Lehrbuch, first edition, pages 219, 220.

Problem 13.—Give a formula expressing the weight of a saturated cubic meter of aqueous vapor at different temperatures.

Solution.—1. The specific gravity of aqueous vapor is 0.622 [6] (air = 1). Aqueous vapor obeys the same laws as to expansion with rise of temperature and decrease of pressure as does air, therefore by analogy with equation (1), problem 12, remembering, however, that the vapor is under its own saturation tension, e, the weight of a cubic meter of aqueous vapor is

$$\frac{0.622\,(1293.05)}{1+\alpha t} \times \frac{e}{760} \; \ldots\ldots\ldots\ldots\ldots \; (2)$$

Example.—What is the weight of a cubic meter of saturated vapor at 30° C?

The vapor pressure, or e, at 30° C. is 31.51 millimeters. Therefore the answer is:

$$\frac{0.622 \times 1293.05 \times 31.51}{(1 + 0.00367 \times 30) \times 760}, \text{ or } 30.09 \text{ grams.}$$

The student should be required to construct a table, giving for every 5° C., using the accepted values of vapor pressure as determined experimentally by physicists, (1) the weight of vapor in a cubic meter of saturated space; (2) the relative weights of the vapor at $t°$ and 0° C; (3) the volume in cubic meters of an amount of vapor weighing 1 gram, viz.:

Temperature.	Vapor pressure.	Weight of vapor in a saturated cubic meter of space.	Change per 5°.	Relative weight to that of 1 cubic meter at 0°.	Volume of 1 gram of vapor.
°C. 30	*mm.* 31.51	*Grams.* 30.09	*mm.* 1.59	6.1408	*Cubic meter.* 0.0332

Problem 14.—At what temperature is the weight in grams of vapor in a cubic meter of saturated space the same as the vapor pressure exprest in millimeters of the mercurial barometer?

Solution.—Equation (2), problem 13, reduces to

$$\frac{0.622\,(1293.05)}{760} \times \frac{e}{(1+\alpha t)} = 1.058\,\frac{e}{(1+\alpha t)}$$

If we put $(1 + \alpha t)$ equal to 1.058, then the weight in grams of a cubic meter of saturated vapor becomes equal to e, the vapor pressure in millimeters of mercury.[7] Solving

$$1 + \alpha t = 1.058 \text{ or } 1 + 0.00367\,t = 1.058$$
$$0.00367\,t = 0.058 \qquad t = 15.8° \text{ C.}$$

At 15.8° the vapor pressure is the same as the weight in grams of a saturated cubic meter of vapor; below that temperature the weight of a cubic meter is greater than the vapor pressure; above that it is less.

Example.—At what temperature is the volume of 1 gram of saturated vapor equal to 1 cubic meter? *Answer.*—At some point between − 15° and −20° C.

Problem 15.—Give a formula expressing the weight of a cubic meter of saturated air.

Solution.—The weight of a cubic meter of saturated air is less than the weight of a cubic meter of dry air at the same t and b, or it is equal to the weight of the vapor at the pressure e plus that of the dry air, at the pressure b—e, for the addition of vapor increases the total pressure and causes an expansion of the volume when both are unconfined as in the ordinary free atmosphere. From equations (1) and (2), problems 12 and 13, we find weight in grams of a cubic meter of saturated air:

$$\frac{1293.05\,(b-e)}{(1+\alpha t)\,760} + \frac{0.622\,(1293.05)\,e}{(1+\alpha t)\,760} \text{ which reduces to}$$

$$\frac{1293.05}{1+\alpha t}\,\frac{(b - 0.378\,e)}{760} \; \ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (1)$$

[6] The specific gravity of aqueous vapor relative to that of dry air at the same pressure and temperature is computed by the formula of physical chemistry more accurately than it has as yet been determined by any direct measurement. The calculation is very simple. Two volumes of hydrogen, whose weight relative to that of air is 2×0.06960 (Rayleigh, 1893), combine with one volume of oxygen, whose relative weight is 1.10535 (Rayleigh, 1897), to form two volumes of saturated aqueous vapor, whose relative weight is therefore 1.24455. Hence, the relative weight of one volume, or the specific gravity of aqueous vapor relative to that of air, is one-half of this, or 0.62228. This computation relates to saturated vapor, but on the assumption that vapor acts like a gas, it becomes true for any temperature and pressure; hence, its use in the above text.—EDITOR.

[7] In all dynamic problems the vapor pressure, like the air pressure, must be exprest in grams per square centimeter, or kilograms per square meter, or pounds per square foot, depending on the system of units that is employed.—EDITOR.

Example.—What is the weight of a cubic meter of saturated air at 10° C.? *Answer.*—At 10° the vapor pressure is 9.14 millimeters. By the formula

$$\frac{1293.05}{1 + 0.00367 \times 10} \; \frac{760 - 0.378 \times 9.14}{760} = 1241.6 \text{ grams.}$$

A cubic meter of dry air at 10° weighs 1247.3 grams; the saturated air weighs 5.7 grams less than an equal volume of dry air.

The student should be required to construct a table giving the weight of a cubic meter of dry air for every 5° C. between − 30° and 35° C., and the weight of a cubic meter of saturated air, and the difference between them. The table may be arranged as follows:

Temperature.	Weight of a cubic meter of dry air.	Weight of a cubic meter of saturated air.	Difference.
°*C.*	*Grams.*	*Grams.*	*Grams.*
10	1247.3	1241.6	5.70

Example.—What is the difference between the weight of a cubic meter of dry air and of saturated air at − 20° and 30° C.? Will be answered by the above table, when completed.

Problem 16.—Give formulas expressing the weight of dry air and the weight of aqueous vapor in a kilogram of saturated air.

Solution.—If a cubic meter of dry air weighs 1.29305 kilograms, then 1 kilogram has a volume of 1/1.29305 cubic meters. Or in general, as one cubic meter of saturated air weighs by equation (1), problem 15,

$$\frac{1293.05\,(b - 0.378\,e)}{(1 + at)\,760} \text{ grams or } \frac{1.29305\,(b - 0.378\,e)}{(1 + at)\,760} \text{ kilograms,}$$

then 1 kilogram will occupy in cubic meters, the reciprocal of that, or 1 kilogram of saturated air occupies

$$\frac{(1 + at)\,760}{1.29305\,(b - 0.378\,e)} \text{ cubic meters} \ldots\ldots (1)$$

In order to know how much dry air is present in this number of cubic meters of saturated air, we must multiply the expression by the quantity of dry air in a cubic meter, given by the first part of equation (1), problem 15, or

$$\frac{(1 + at)\,760}{1.293\,(b - .378\,e)} \times \frac{1.293\,(b - e)}{(1 + at)\,760} = \frac{(b - e)}{(b - .378\,e)}.$$

The number of kilograms of dry air in 1 kilogram of saturated air is

$$\frac{(b - e)}{(b - .378\,e)} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In a similar manner by multiplying the expression (1) by the second part of equation (1), problem 15, giving the quantity of aqueous vapor in a cubic meter, we get an expression giving the number of kilograms of vapor in 1 kilogram of saturated air, or

$$\frac{(1 + at)\,760}{(b - .378\,e)\,1.293} \times \frac{0.622 \times 1.293 \times e}{(1 + at)\,760} = \frac{0.622\,e}{(b - .378\,e)}.$$

The number of kilograms of vapor in a kilogram of saturated air is

$$\frac{0.622\,e}{(b - .378\,e)} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Problem 17.—How much dry air and how much aqueous vapor are contained in a kilogram of saturated air at 10° C?

Solution.—By applying the formulas of problem 16, we get, since e at 10° is 9.14 mm:—

$$\text{from (2) dry air } \frac{760 - 9.14}{760 - .378 \times 9.14} = 0.99247 \text{ kilogram.}$$

$$\text{from (3) vapor } \frac{0.622 \times 9.14}{760 - .378 \times 9.14} = 0.00753 \text{ kilogram.}$$

$$\text{Sum} = 1.00000 \text{ kilogram.}$$

The student should be required to construct a table giving (1) The volume which 1 kilogram of dry air occupies at different temperatures; (2) The volume which 1 kilogram of saturated air occupies; (3) The quantity of dry air in a kilogram of saturated air; (4) The quantity of vapor in a kilogram of saturated air. Example:

Temperature.	Volume of 1 kilogram of dry air.	Volume of 1 kilogram of saturated air.	Weight of dry air in 1 kilogram of saturated air.	Weight of vapor in 1 kilogram of saturated air.
°*C.*	*Cubic meter.*	*Cubic meter.*	*Kilogram.*	*Kilogram.*
10	0.8017	0.8054	0.99247	0.00753

An extended table of the weights of aqueous vapor in a kilogram of saturated air under various pressures, in the metric system, will be found in Bigelow's Cloud Report, pages 560 and 561. See also Marvin's tables for the Psychrometer and Smithsonian Meteorological Tables.

All these problems may also be solved for other pressures than 760 mm.

[*To be continued.*]

NOTES ON THE CLIMATE OF KANSAS.

By T. B. JENNINGS, Section Director. Dated Topeka, Kans.

[Read before the Kansas Academy of Science November 30, 1906.]

In reviewing the history of a country it is customary to divide it into prehistoric and historic periods. In writing of the climatology of this State we shall divide it into two periods, the first period extending from the earliest reliable written accounts of its weather down to the time (1887) that systematic observations and records were practically begun over the entire State. Tho the State is young, it has a few records that began in the dim past. The Fort Leavenworth record began in 1836, the Fort Riley record in 1853, the State Agricultural College record in 1858, the Kansas University record in 1868, the Independence record in 1872, and the Dodge record in 1875.

FLOODS.

The old river boatmen give an account of a flood in the eastern part of the territory and in the Missouri River in 1785 which past down that river and into the Mississippi, flooding the American bottoms across from St. Louis, and which for many years was referred to as "The Great Flood." Twenty-six years later the Missouri River bottoms were again flooded.

About the last of February or first of March, 1826, heavy rains began in what is now the southeast quarter of the State, raising the Neosho and its tributaries "out of their banks" and flooding their bottoms; heavy rains continued in the territory during the season. In June the lowlands near the mouth of the Kaw were flooded, owing to high water in the Kaw and Missouri rivers meeting; in the fall a destructive flood swept down the Neosho, carrying away wigwams, houses, and gathered and ungathered crops.

In 1844 occurred probably the worst floods eastern Kansas has ever experienced. Rev. Mr. Meeker, who was missionary to the Ottawa Indians and was living on what is now the site of the city of Ottawa, in his letters gave a graphic account of the condition of the Marais des Cygnes and the destruction wrought by it at that point. From the 7th to the 20th of May there were nine days of rain, and daily from the 23d to the 29th, inclusive, rain fell; it began again on June 7, and on the 12th the Marais des Cygnes overflowed its banks, carrying away outhouses, fences, cattle, pigs, and chickens; the river began falling on the 14th and began rising again on the 20th.

At Fort Leavenworth the rainfall for June, 1844, was 8.53 inches; for July, 12 inches; for August, 8.08 inches, aggregating 28.61 inches for the three months. (The normal annual precipitation for that place is 30.89 inches.) Mr. Richard W.

Cummins, of the Fort Leavenworth Agency, reported to the Government: "All those farming on the bottom lands of the Kansas River and other bottom lands lost their crops entirely, and not only their crops, but nearly all their stock, hogs, cattle, and even horses. * * * The Konzas farm is mostly on the bottom lands of the Kansas River, which was overflowed from bluff to bluff." S. M. Irvin, Indian Agent in charge of the Great Nemaha Subagency, reported: "The past season, you must be aware, has been a most unpropitious one for farming operations. The unprecedented fall of rain which took place in June and July, by which much of the best farming land of the Indians was several times inundated, has been a serious drawback upon the aggregate value of the farming products."

W. W. Cone in his "Shawnee County History", speaking of the flood of 1844, says: "During the flood Major Cummings, Paymaster of the U. S. Army, wishing to cross from the south to the north side of the Kaw River at Topeka stepped into a canoe at about the present site of the corner of Topeka avenue and Second street and was rowed by an Indian from there to the bluffs, near the present residence of J. M. Harding, in Soldier township, the water then being 20 feet deep over the ground where North Topeka now stands".

Mr. P. E. Chappell, of Kansas City, Mo., an old river steamboatman, states that the flood of 1844, in the Missouri River, was confined to the lower river and adds: "The entire bottom from the Kaw to the mouth of the Missouri was completely submerged, and from bluff to bluff presented the appearance of an inland sea". He further states that in 1845 and in 1851 there was unusually high water in the river and all the second bottoms and low slough were submerged. We find that at Fort Leavenworth 15.80 inches of rain fell during June, 1845, while in 1851 the Fort Leavenworth record shows for May 6.40 inches, for June 8.16, July 6.78, and August 5.02, a total of 26.36 inches.

THE DROUGHT.

Mr. E. C., in his paper "In at the birth, and–" says in part: "During the winter of 1859-60, the sun shone forty-five consecutive days thro a cloudless sky upon a snowless plain. Thru the summer of 1860 the hot wind parched the soil and no harvest followed the seed time; hence the approaching winter brought an alarming outlook". (He was living in Marshall County then.)

Mr. Wm. H. Coffin, who settled in Leavenworth County in the 50's, speaking of the drought, says in part: "In the great drought in Kansas, from June 19, 1859, to November, 1860, not a shower of rain fell at any one time to wet more than two inches deep, and but two light snows in the winter ('59-60). Roads never got muddy, and the ground broke open in great cracks. There were no vegetables whatever, and a burning hot wind in July and August withered everything before it. Fall wheat came up in the spring but withered and died; most counties did not harvest a bushel. Low bottom lands, where well tilled, gave some corn, but most other lands dry fodder. Prairie grass grew until July, then all withered and died—enough was secured mostly from low bottom lands. Wells, springs, and streams dried up".

The Hon. Geo. W. Martin, in an address before the Old Settlers' Association of Geary County, September 21, 1901, said in part: "The changed condition in Kansas is indicated by the tone of the people during the recent dry spell. It is no easy matter to reclaim a new country, but the people of Kansas have accomplished marvels. The drought of 1860 began September 1, 1859, from which date there was no rain until September or October, 1860. * * * On the 13th of July the mercury went up to 112° and 114° in the shade (the highest temperature at Manhattan was 115°), and, with a hot scorching wind, it kept at these figures for weeks. The leaves withered and fell off the trees, and eggs roasted in the sand at midday. The dates of the beginning and ending of the drought vary in locations, but it may be said that there were from twelve to fourteen months between rains".

Horace Greeley, writing in the New York Independent of February 7, 1861, referring to the drought of the preceding year, said: "* * * Drought is not unknown to us; but a drought so persistent and so severe as that which devastated Kansas in 1860 is a stranger this side of the Mississippi. No rain, or none of any consequence, over an area of 40,000 square miles, from seed time till harvest—wheat, Indian corn, buckwheat, successively deposited in the earth, to die without germination, or to start only to be blighted and wither for want of moisture".

Mrs. Susie M. Weymouth, in the Daily Capital, July 19, 1901, says: "The drought of 1860 gave to Kansas the ignominous name, 'droughty Kansas'. * * * It seemed for a time that the powers of heaven and earth were against us. * * * Previous to 1860 a good many trees were planted. The hot winds of that summer told on them, and in after years the south side of the trees told of the fearful heat which they had past thru, for there was always a dead part. That year will go down in history as having the hottest day on record. * * * It was in July * * * a frightful day. People fled to their cellars and every door and window was closed. It was as if the wind was coming from a red-hot furnace for nine or ten hours. Next day we looked to see what damage it had done—birds, chickens, and stock had succumbed and the trees were badly injured; the tender things for two feet on the south side were as dead as if a fire had swept thru them".

The year 1874 has been called a drought year, but it was not; it was a grasshopper year.

CLAYDEN'S CLOUD STUDIES.

As we often have occasion to refer to the volume entitled "Cloud Studies", by Arthur W. Clayden,[1] it seems proper to call the attention of American observers and students to this excellent work, which in some respects supplements the important papers published by our American colleague, Mr. H. H. Clayton, of Blue Hill Observatory. Mr. Clayden has been a long time known to meteorologists as the secretary of the special committee on meteorological photography, of the British Association for the Advancement of Science, and he has published annual reports on that subject since 1890. He was a wrangler in the Tripos, Christ College, Cambridge, 1876, and science master at Bath College, 1878, and is now principal of the Royal Albert Memorial College, Exeter; he is therefore thoroly familiar with the physical problems that enter into cloud study, and with the laboratory methods necessary to secure good photographs and accurate measurements. His present volume shows that perfect familiarity with the subject that enables one to write "down to the level of the nontechnical reader" without making any technical mistakes; so that this book will be for a long time treasured as one worth reading and studying. The work is not merely a collection of halftones, with descriptions of the clouds, but it is full of suggestions as to their methods of formation, and will stimulate the reader to further studies. It is the work of an independent thinker, who does not often go far astray from the facts and principles that belong to exact science.

Some items that have caught our attention may be worth mentioning, but really every one of the 180 pages contains something good.

On page 16 the author urges the advantage of observing delicate details by studying the reflection of a cloud in a black glass mirror; we are sorry to find that his book is so wholly taken up with photographic work that he has, we believe, not even mentioned the nephoscope and the ordinary use of the

[1] Published by John Murray, London, 1905.

black mirror in that instrument. Of course the nephoscope and its methods are crude compared with photography, but it should be in everyone's hands, even if one also has a photogrammeter.

In the introduction Mr. Clayden indicates the need of a much more elaborate system of names for clouds than is afforded by the simple international system. He would like to have that considered as a list of the names of cloud *genera* and as open to elaboration by the insertion of specific names for varieties, whose peculiarities depend upon the conditions under which they are formed. The present writer would add that in August, 1895, at the meeting of the American Association for the Advancement of Science, at Springfield, Mass., he submitted quite an elaborate system of notation and symbols (as being better than a list of Latin names), by which he was able to indicate to the eye at a glance many of the conditions leading to the formation of any special variety of cloud. It was a sort of picture writing that would appeal to everyone, and be adaptable to all possible combinations, and could easily become an international system. The discussion that followed the presentation of the paper was so discouraging that the author has refrained from publishing it, but may do so at some future time, as it partially meets the needs indicated by Mr. Clayden.

Sixteen varieties or genera of clouds were recognized by the International Cloud Atlas, and 35 additional varieties or species, with their names, occur in the course of Mr. Clayden's volume, all of which are systematically arranged in his tenth chapter; we quite agree that, as the author suggests, further additions, and in fact numerous ones, must be made when we come to study clouds in other climates than that of England.

Apparatus and photographic methods are described in the latter part of the book, so that anyone may begin at once to follow in the author's footsteps. Historical matters are mentioned in the introductory chapter, but our special interest is attracted by the material published in Chapters II–VIII. Beginning with the cirrus cloud Clayden mentions that the loftiest variety, which he calls the cirrus-excelsus, is visible like a silvery curtain when the whole sky is so dark that third and fourth magnitude stars are visible. This is the so-called phosphorescent cloud, or nocti-luminous cloud, but it is not likely that the cloud is self-luminous; it is more likely that it is visible by its reflection of very distant twilight. The highest altitude obtained for a specimen of this cloud is given on page 32 as 17.02 miles, or more than 27,000 meters, on the afternoon of June 12, 1899, at Exeter. But on page 150 the same cloud apparently is spoken of as observed one morning, on a day of very hot, damp weather, at the altitude of 27,413 meters, or about seventeen miles. We believe that there is only one observation of this kind of cloud on record in the United States.[1] Of course at this altitude clouds formed of aqueous particles, whether water or ice, are extremely improbable and not likely to be dense enough to be visible. The rate of diminution of vapor pressure with ascent is such that visible clouds more than fifteen miles high must be of the rarest occurrence. But on the other hand clouds of meteoric matter are very common, and it is worth inquiring whether our noctiluminous clouds, or cirrus excelsus, may not be of some such foreign origin, like the auroral clouds and other phenomena that are supposed to depend upon the electrons of cosmic space.

In Plates XX and XXI Clayden gives companion pictures taken within a half minute of each other, looking toward the west and the northwest, respectively, giving us a panorama of the western sky while the sun was nearing the horizon. The photographs, therefore, represent the under surface of a sheet of hazy cirro-cumulus illuminated by the setting sun. The gorgeous sunset colors on these clouds can not be given. The clouds themselves were composed of icecrystals that had a half hour previously given rise to a solar halo.

Numerous references to the relations between clouds and subsequent weather are given. Thus on page 81 Clayden states that he has made a series of measurements of the thickness of clouds necessary to the production of a shower of rain. In winter no rain will fall from a cloud unless its thickness is at least a hundred meters; in summer the thickness must be rather greater. If, however, the temperature is so low that the cloud is formed only of flakes of snow, then this may fall from a layer of thin lifted fog not quite thick enough to hide the blue color of the sky. Under ordinary conditions of temperature rain is unlikely, or small and trifling, if the thickness is less than two thousand feet or six hundred meters. The heaviness of the rain and the size of the drops increase with the thickness of the cloud. If the height from base to summit be two or three thousand feet the fall will be gentle; four thousand to six thousand feet gives large drops and a fairly heavy shower; six thousand to ten thousand feet in the summer time gives cold heavy rains and hail. In general the rain cloud does not differ in any way from the rainless, except in thickness.

In the same connection (on page 96), speaking of the cumulus Clayden adds that small cumuli, less than one hundred and twenty meters thick, rarely produce rain, and nothing like a heavy shower is likely unless the thickness exceeds four hundred meters. As the cumulus drifts over the landscape it seldom maintains its showery character for more than ten or fifteen miles, often for much less. Its activity as a rain producer is checked by the checking of the ascending currents of air, both by the mechanical action of the falling raindrops and by the cooling influence of these drops on the lower part of the ascending column. The formation of long trains of cumuli in connection with the hills or other orographic features, is fairly well explained, but we hardly agree with Clayden's suggested explanation of the fact that the relative humidity within clouds and fogs is generally observed to be less than 100 per cent.

Chapter VIII is given up to wave clouds, and suggests many problems for both the observer, the experimentalist, and the mathematician.—*C. A.*

WEATHER BUREAU MEN AS EDUCATORS.

The following lectures and addresses by Weather Bureau men are reported:

Mr. M. E. Blystone, December 18, 1906, before the Franklin Society of Providence, R. I., on "The Work of the Weather Bureau".

Mr. N. B. Conger, of the Detroit, Mich., office, December 6, 1906, before the Windsor Literary and Science Club, of Windsor, Ont., on "The Weather Bureau and its Work".

Mr. P. Connor, October 11, 1906, before the pupils of the Manual Training High School, Kansas City, Mo., on weather topics; also December 16, 1906, before a bible class of the Independence Avenue Methodist Church, on "Meteorological Instruments and Weather".

Mr. H. W. Richardson, December 12, 1906, before the Men's League of the First Methodist Church, Duluth, Minn., on "The U. S. Weather Bureau"; also December 28, 1906, before the Northern Railway Club, on "Weather in its Relation to Railroad Operations".

Mr. J. Warren Smith, November 30, 1906, before the Ohio Academy of Science, at its annual meeting, in Columbus, Ohio, on "Weather and Crop Yield".

Classes from schools and academies have visited Weather

[1] See the Monthly Weather Review for December, 1904, page 560, where Rev. W. S. Rigge records an observation made on July 18, 1904, at Omaha, but the altitude is not stated.

Bureau offices, to study the instruments and equipment and receive informal instruction, as reported from the following offices:

Des Moines, Iowa, December 18, 1906, the physical geography class from the North High School.

Duluth, Minn., December 15, 1906, members of the physiography section of the Superior, (Wis.) State Normal School.

Kansas City, Mo., November 14, 1906, a class from Loretto Academy.

Little Rock, Ark., December 12, 1906, the science class from the Little Rock, High School.

Mobile, Ala., December 7, 1906, a section of the girls' class in physics from Barton Academy; also December 13, a section of the boys' class in physical geography from Barton Academy; also December 14, the class in physics from McGill Institute.

Raleigh, N. C., December 15, 1906, the physical geography class from Peace Institute.

San Jose, Cal., December 12, 1906, the physics class from the San Jose High School.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

H. H. KIMBALL, Librarian.

The following titles have been selected from among the books recently received, as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies. Most of them can be loaned for a limited time to officials and employees who make application for them.

American Association for the Advancement of Science.
Proceedings. 55th meeting, New Orleans, Dec., 1905–Jan., 1906. Washington, 1906. 589 pp. 8°.

Association Française pour l'Avancement des Sciences.
Compte rendu de la 34me session. Paris. 1906. 1120 pp. 8°.

Bezold, Wilhelm von.
Gesammelte Abhandlungen aus den Gebieten der Meteorologie und des Erdmagnetismus. Braunschweig. 1906. viii, 448 pp. 8°.

Black, F. A.
Terrestrial magnetism and its causes... London. 1905. (12), 226 pp. 8°.

Börnstein, R[ichard].
Der neuerrichtete öffentliche Wetterdienst für Norddeutschland. (S. A. Verh. phys. Ges. Braunschw. 8 Jahrg. No. 20.) Braunschweig. 1906. Pp. [511]–513. 8°.
Die halbtägigen Schwankungen der Temperatur... (S. A. Verh. phys. Ges. Braunschw. 8 Jahrg. No. 20.) Braunschweig. 1906. Pp. [517]–518. 8°.

Bracke, A.
La densité de la neige. Bruxelles. 1906. 31 pp. 8°.
Mon baromètre. 2 ed. Mons. 1906. 20 pp. 8°.
La photographie des nuages. Mons. 1905. 28 pp. 16°.
La représentation des situations atmosphériques. Mons. 1904. 32 pp. 8°.

British East Africa. Agricultural Department.
Meteorological conditions. Leaflet 11. [Mombasa]. 1905. 4 pp. 12°.
Meteorological reports. 1904. n. p. 1905. 40 pp. 8°.
Same. 2d annual report. 1905. n. p. 1906. [24] pp. 8°.

Cafiero, Federico.
Il R. Istituto Nautico "Ruggero di Lauria" in Riposto. Riposto. 1905. 111, [3] pp. 4°.

Canada. Meteorological Service.
Report for... 1904. Ottawa. 1906. (18), 278 pp. 4°.

Crespin, J.
Le climat d'Alger au point de vue hivernal. (Extr. Compt. rend. Congrès Soc. savantes, 1905. Sciences.) Paris. 1905. 7 pp.

Exner, Felix M.
Grundzüge einer Theorie der synoptischen Luftdruck. Wien. 1906. 76 pp. 8°.

Fritzsche, Richard.
Niederschlag, Abfluss und Verdunstung auf den Landflächen der Erde. Inaug-Diss... Halle-Wittenberg. Halle a S. 1906. [2], 54, [2] pp. 8°.

Hadden, David E.
Progress and problems of solar physics during the last fifty years. (Repr. Proc. Sioux City acad. sc., Alta, Iowa. v. 2.) [1906.] 6 pp. 8°.

Hogarth, David George.
...The penetration of Arabia... New York. [1904.] xiii, 359 pp. 12°.

Jeans, J. H.
The dynamical theory of gases. Cambridge. 1904. [4], 352 pp. 4°.

Johnston, Sir Harry.
Liberia. 2 vols. London. 1906. (28), 519; (16), 1183 pp. 8°.

Köppen, W.
Klimakunde. I. Allgemeine Klimalehre. Leipzig. 1906. 132, [2] pp. 24°.

Lenard, P.
Ueber Kathodenstrahlen... Leipzig. 1906. 44 pp. 8°.

Millot, C.
Brouillards de mars et gelées de mai. La lune rousse. (Extr. Bull. Soc. sc. Nancy.) Nancy. 1905. 10pp. 8°.
L'été de la Saint-Martin. (Extr. Bull. Soc. sc. Nancy.) Nancy. 1906. 8 pp. 8°.

Mitchell, J. Cairns.
Results of meteorological observations taken in Chester during 1904. (Repr. Proc. Chester soc. nat. sc., Chester. 1904–5.) n. p. [190?] 4, [4] pp. 8°.

Moedebeck, H. W. L.
Die Luftschiffahrt, ihre Vergangenheit und ihre Zukunft; insbesondere das Luftschiff im Verkehr und im Kriege. Strassburg. 1906. (6), 137 pp. 8°.

Neesen, Friedrich.
Die Sicherungen von Schwach- und Starkstromanlagen gegen die Gefahren der atmosphärischen Elektricität. Braunschweig. 1899. 120 pp. 8°.

Paris. Observatoire Municipal de Montsouris.
Annales. Tome 6. Paris. 1905. 495 pp. 8°.

Richard, L.
Géographie de l'Empire de Chine... Chang-hai. 1905. [18], 564, (22) pp. 12°.

Rodriguez de Prada, Angel.
Meteorologia dinamica. 2 ed. Madrid. 1902. vii, 158 pp. 4°.

Schoentjes, H.
Fleurs de la glace. Gand. 1905. 43 pp. 39 pl. 8°.

Sommer, Emil.
Die nicht auf den Meeresspiegel reduzierten Jahres-, Januar-, April-, Juli- und Oktober-Isothermen Deutschlands. Inaug.-Diss... Freiburg i. B. Mannheim. 1906. 83 pp. 8°.

Stützer, Arnold.
Vergleichende Temperaturmessungen zu Marburg a. d. L. und seine barometrische Meereshöhe. Inaug.-Diss... Marburg. 1906. 67 pp. 8°.

—— ——.
The voyage of the *Scotia*. Being the record of a voyage of exploration in Antarctic seas. By three of the staff. Edinburgh. 1906. (24), 375 pp. 8°.

Weise, W.
Die Kreisläufe der Luft nach ihrer Entstehung und in einigen ihrer Wirkungen. Berlin. 1896. 4, [2], 86 pp. 8°.

Zuntz, N. and others.
Höhenklima und Bergwanderungen in ihrer Wirkung auf den Menschen. Berlin. 1906. xvi, 494 pp. 4°.

RECENT PAPERS BEARING ON METEOROLOGY.

H. H. KIMBALL, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

Astrophysical Journal. Chicago. Vol. 24. Dec., 1906.
Very, Frank W. The temperature of the moon. Pp. 351–354.

Geographical Journal. London. Vol. 29. Jan., 1907.
—— The Alps as a weather-parting. P. 84.
—— Hoar-frost at high altitudes. [Note.] P. 95.

Journal of the Meteorological Society of Japan. Tokio. 25th year. Nov., 1906.
Sasaki, T. Result of examinations of the pulse-rate on Mount Fuji.

Nature. London. Vol. 75.
G., F. Scientific work on Mont Blanc. (Dec. 27, 1906.) Pp. 203–204.
Collins, F. G. Emerald green sky color. (Jan. 3, 1907.) P. 224.
Hann, J[ulius]. Indian climatology. (Jan. 10, 1907.) Pp. 241–244.

London, Edinburgh, and Dublin Philosophical Magazine. London. 6 ser. Vol. 13. Jan., 1906.
Chree, C. Auroral and sun-spot frequencies. Pp. 149–164.

Popular Science Monthly. New York. Vol. 70. Jan., 1907.
Meier, Konrad. The sanitation of air. Pp. 19–32.

Proceedings of the American Academy of Arts and Sciences. Boston. Vol. 42. Dec., 1906.
Rotch, A. Lawrence. Results of the Franco-American expedition to explore the atmosphere in the tropics. Pp. 263-272.
Science. New York. New Series. Vol. 24.
Ward, R[obert] DeC[ourcy]. Thunderstorms and the moon. [Note on article by C. W. Hissink.] (Dec. 28, 1906.) P. 866.
Science. New York. New Series. Vol. 25.
Ward, R[obert] DeC[ourcy]. Climate and climatic changes in Kashmir. [Note.] (Jan. 18, 1907.) P. 114.
Scientific American. New York. Vol. 95.
Albrecht, Herrmann. The German research boat *Planet.* (Dec. 22, 1906.) P. 464.
Scientific American. New York. Vol. 96.
—— Climate: past and present. (Jan. 19, 1907.) P. 67.
Rotch, A. Lawrence. The exploration of the atmosphere at sea. Pp. 70-71.
Bulletin de la Société Belge d'Astronomie. Bruxelles. 11 année. Nov., 1906.
Arabeyre, —. Méthode de prévision du temps d'après un type isobarique spécial. Pp. 426-433.
Ciel et Terre. Bruxelles. 27 année. 1 jan., 1907.
—— Le contre-alizé de sud-est à sud-ouest. [Note.] P. 555.
—— Les variations barométriques de longue dureé sur des étendues considerables. [Note.] P. 558.
La Nature. Paris. 35 année. 15 déc., 1906.
Bourgeois, Henry. Les tempêtes des grands lacs Américains. Pp. 36-38.
Revue Néphologique. Mons. Déc., 1906.
Bracke, A. A propos des héliographes. Pp. 89-90.
Bracke, A. Une cause de fortes pluies locales. Pp. 90-92.
Annalen der Hydrographie und Maritimen Meteorologie. Berlin. 34 Jahrgang.
—— Die Erforschung der höheren Schichten der Atmosphäre an Bord S. M. S. *Planet.* Die Forschungsreise S. M. S. *Planet.* XXII. (Heft 11, 1906.) Pp. 505-510.
Prager, M. Ueber die Beziehungen des Monsunregens in Indien zu Wetterlagen entfernterer Gegenden und vorangegangener Zeiten. (Heft 12, 1906.) Pp. 562-565.
Gaea. Leipzig. 43 Jahrgang. Jan., 1907.
—— Cirruswolken und Regen. P. 57.
—— Der Taifun vom 18 September 1906. Pp. 57-58.
—— Die Druck und Temperaturverhältnisse in den hohen Schichten der Atmosphäre. Pp. 58-59.
Geographische Zeitschrift. Leipzig. 12 Jahrgang. 11 Heft. 1906.
Keller, H. Die Abflusserscheinungen in Mittel-Europa. Pp. 611-630.
Meteorologische Zeitschrift. Braunschweig. Band 23. Dec., 1906.
Quervain, A[lfred] de. Neue Beweise für die Realität der oberen Inversion in 8 bis 13 km Höhe. Pp. 529-540.
Birkeland, B. J. Mitteilungen aus dem norwegischen meteorologischen Institut. Die tägliche Periode des Luftdruckes und der Temperatur in Norwegen. Pp. 540-546.
Marloth. Ueber die Wassermengen, welche Sträucher und Bäume aus treibendem Nebel und Wolken auffangen. Pp. 547-553.
Maurer, Jul. Dr. August Weilenmann. Pp. 553-554.
H[ann], J[ulius]. Dines über die vertikalen Temperaturgradienten an der Westküste von Schottland und Oxshott (Surrey). Pp. 554-555.
H[ann], J[ulius]. Okada über die Wärmeleitung des Schnees. Pp. 555-556.
Hergesell, H[ugo]. Ueber lokale Windströmungen in der Nähe der Kanarischen Inseln. Pp. 556-559.
Hann, J[ulius]. Die Windrichtüng auf dem Gipfel des Pik von Teneriffa. Pp. 559-561.
Krebs, Wilhelm. Das Klima der Karolineninsel Kusaie oder Ualan. Pp. 561-562.
Sapper, Karl. Meteorologische Beobachtungen, angestellt in den Republiken Guatemala und Salvador 1905. Pp. 562-564.
Brückner, Ed. Schwankungen des Niederschlages im Deutschen Reich 1816-1900. Pp. 565-566.
—— Bergwitz über den Einfluss des Waldes auf die Elektrizitätszerstreuung in der Luft. P. 567.
—— Regenfall zu Port Durban in Natal. Pp. 567-568.
—— Regenmessungen in Kamerun. Pp. 568-570.
Hann, J[ulius]. Meteorologische Beobachtungen in Montevideo und in Uruguay. Pp. 570-571.
Exner, Felix M. Bemerkungen über die Zusammensetzung einer geradlinigen Luftströmung mit der Luftbewegung eines Wirbelsturmes. Pp. 571-573.
Rheden, J. Wolkenhöhenmessungen mit Scheinwerfern. P. 573.
—— Das Feuerschiff in der Bay Chaleur, Neu-Braunschweig. P. 573.
—— Ueber die vertikale Temperaturabnahme in der Sonnenatmosphäre. Pp. 573-574.
H[ann], J[ulius]. Meteorologische Beobachtungen auf Kuba. P. 574.
Janezic, Eugen. Besonders intensives Morgenrot. Pp. 574-575.
—— Temperatur von Maracaibo, Venezuela. P. 575.
—— Hagelfall im Golf von Mexico. Pp. 575-576.
Physikalische Zeitschrift. Leipzig. 7 Jahrgang. 15. Dez., 1906.
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FORECASTS AND WARNINGS.

By Prof. A. J. HENRY, temporarily in charge of Forecast Division.

Over and near the British coasts barometric pressure fluctuated during the first half and continued high during the latter half of the month. In the vicinity of the Azores pressure was high until the 15th, fell from the 16th to the 21st, rose rapidly from the 22d to 27th, and during the last four days of the month was remarkably high. Over the western Atlantic the barometer fell to a minimum of 28.80 inches over Newfoundland on the 4th, fluctuated from the 5th to 12th, was high from the 13th to 21st, began falling on the 22d, and reached 29.80 inches at Bermuda on the 25th. During the 26th and 27th the barometer rose near the American coast and continued high in that region during the balance of the month.

In the United States December was unseasonably warm in the Southwestern States and the middle and southern Rocky Mountain districts, and was colder than usual over the northern portions of the country east of the Rocky Mountains. During the third decade of the month a cold wave visited the eastern half of the country. In Florida the duration and intensity of this cold wave was remarkable. During the period, December 23-27, freezing temperatures occurred over practically the entire peninsula, and on one or more nights the cold was more intense in south-central than in northern districts of the State. This with other Florida cold waves will be made a subject of future discussion.

Precipitation was deficient in the Atlantic and Gulf States, on the north Pacific coast, and in an area extending from the western Lake region to northwestern Texas. Precipitation was in excess of the December average from the lower Lake region to the interior of Texas, generally in the Northwest, and in New Mexico, Arizona, and California.

The first important storm of the month in the United States advanced from the southern California coast to the Canadian Maritime Provinces from the 2d to the 7th, attended during the 5th and 6th by strong gales on the Great Lakes, and on the 6th and 7th by high southerly shifting to northwesterly winds on the middle Atlantic and New England coasts. The passage of this disturbance was followed by a cold wave that covered the Northwestern States on the 6th and extended thence over the Middle Atlantic and New England States during the 7th, with temperatures below zero generally in New England and the interior of New York on the morning of the 8th. During the 6th a storm of marked strength passed inland from the North Pacific, attended by heavy gales in the North Pacific coast States, and by high winds and rain in California. The second cold wave of the month appeared over Manitoba on the morning of the 10th, and sweeping eastward over Canada produced extremely low temperature in northwestern New England on the 12th. On the 10th a storm of exceptional severity appeared on the north Pacific coast and advanced thence over the continent. From the 16th to 19th a cold wave advanced from the Northwest eastward over Canada, with very low temperatures in the interior of New England.

The display of storm warnings on Lakes Superior, Michigan, Huron, and St. Clair was discontinued for the season at the termination of December 18, and on Lakes Erie and Ontario at the termination of December 20. The display of storm warnings on Lake Pepin was discontinued at the termination of December 10, 1906.

BOSTON FORECAST DISTRICT.

The marked features of the weather were the large amount

of cloudiness and the deficiency in temperature. From the 2d to the 21st the temperature was generally below normal, with several well-defined cold waves, the most marked of which were those of the 8th, the 12th, and the 19th. The lowest temperature during the month in the three southern States occurred with the cold wave of the 8th. The greatest severity of the cold of the 12th was confined to Maine and Vermont, with temperatures ranging from 22° to 25° below zero. These figures were nearly paralleled on the 19th. During the last decade of the month the temperatures were decidedly higher, generally above normal, and without zero readings. The precipitation of the month was somewhat above normal, and occurred on an average of eleven days, but there was no day without a trace or more at some stations. There were no severe storms of either snow or wind. Gales of moderate force occurred on several dates, resulting in considerable delay and inconvenience to shipping, but without wrecks or loss of life. No gales occurred without warnings.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.

The month, as a whole, was unseasonably warm. Exceptionally high temperatures prevailed during the first half of the month. The precipitation was excessive in western Texas and Arkansas and at a few points in northwestern Louisiana and eastern Texas. No cold waves of any extent nor storm winds occurred during the month, and no warnings were issued. Frost or freezing temperature warnings were issued on six dates. A general freeze occurred over Arkansas, Oklahoma, the interior of Texas, and northwestern Louisiana on December 18, for which warnings were issued. Warnings were issued in advance of all frosts.—*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.

The month was remarkable for the unusually large number of pressure areas that past across the central valleys, influencing the weather conditions over this district. The depressions were mostly large in area but rather weak in gradient, hence there were a great many cloudy, rainy days, but no destructive storms. The center of most of the disturbances past to the north of the Ohio River, keeping this district in southern quadrants, with the result that unusually mild temperatures prevailed. There was practically but one cold period, the 22d–26th, inclusive, which was also the only clear period. Light, moist snow fell at intervals during the period 19th–23d, but there was little or no snow on the ground at any time.

No cold wave or special warnings were issued and none were required, altho very decided falls in temperature were featured in the forecasts several times.—*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.

The temperature was generally above normal over central and eastern portions of the district. Several periods of cold weather, with temperatures near zero, or below, marked the conditions over the western and northern portions. Cold-wave warnings were issued on several dates: 5th, 6th, 8th, 10th, 13th, 14th, 16th, 17th, and 31st, when the morning charts indicated the advance of the cold areas in the Northwest. The southern movement of these cold areas, however, was generally not extensive, the advance being usually well to the north. One of the most marked areas was that following the warnings issued on the 6th, and zero temperatures were recorded over Minnesota, Wisconsin, upper Michigan, and portions of northeastern Iowa. Temperatures of from 10° to 20° below zero were present in the valley of the Red River of the North on the morning of the 10th, but the intensity of the cold area was rapidly broken, and rising rather than falling temperatures occurred during its progress eastward. The warnings of the 14th applied to the middle Mississippi Valley, and altho zero temperatures were not reached decided falls of more than 20° occurred at nearly all stations to which warnings were sent.

The season for the display of storm warnings on the upper Lakes closed on the 18th. Only one display had been ordered up to that time. Warnings were issued on the morning of the 5th in advance of the storm which moved from the middle Rockies eastward and northeastward, passing across the Lake region during the night of the 5–6th and disappearing from the St. Lawrence Valley by the morning of the 8th. Northeast warnings were hoisted on Lake Superior and southeast on Lakes Michigan and Huron, and high winds with snow were reported from many of the display stations. No conditions warranting the issuance of advisory messages occurred after the close of the season.—*Frank H. Bigelow, Professor of Meteorology.*

DENVER FORECAST DISTRICT.

The month was unusually mild thruout the district. A deficiency of precipitation was noted on the middle-eastern slope and in southern Utah; elsewhere there was an excess, notably in northern and central Arizona, where the amounts were the greatest of record for December. There were no cold waves.—*Frederick H. Brandenburg, District Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.

The month was marked by several severe storms. On December 3 a moderate disturbance developed over southern California and moved slowly eastward, causing rain south of the Tehachapi for several days. On the 6th a disturbance of great depth appeared on the Washington coast and caused rain and high southerly winds south of the Tehachapi. Another disturbance forty-eight hours later moved rapidly southeastward, also causing general rain. The most severe storm of the winter occurred on the 10th, covering the entire coast. At San Francisco a maximum wind velocity of 53 miles occurred; at Southeast Farallon, 72 miles, and at Point Reyes Light, 92 miles from the south. The storm did considerable damage thruout the southern portion of the State, and especially in the San Francisco Bay district. Warnings were given a few hours in advance of the storm. A period of comparatively quiet weather followed, lasting until the 22d. The last week of the year was marked by showery weather, with heavy rain on the 25th and 26th.—*Alexander G. McAdie, Professor and District Forecaster.*

PORTLAND, OREG., FORECAST DISTRICT.

Two severe storms swept this district during the motnh of December. The first was noted as approaching the Washington coast the morning of the 6th and warnings were at once sent to all seaports and inland stations were at once notified of the expected high winds. Fifteen hours later the winds had increased to a whole gale along the coast, and within twenty-four hours high winds were blowing at inland stations. The Oregonian editorially commended the work of the Weather Bureau in connection with this warning, saying that "with a warning so well in advance of the storm, there was plenty of time to make everything snug, and as a result, very little damage was reported".

The second storm was first noted as approaching the Oregon coast the morning of the 10th at which time there was some doubt as to weather it would move directly east or advance northeastward. It was finally decided that it would move northeastward and warnings were promptly issued. This storm proved to be as severe as the former one and the warnings were just as timely.

With the exception of these two storms the month was featureless, with no severe cold spells and with precipitation below normal west of the Cascade Mountains and generally slightly above normal to the east of this range of mountains.—*Edward A. Beals, District Forecaster.*

RIVERS AND FLOODS.

There were no floods of great consequence during the month. Stages were high for the season in the Ohio River

and the lower Mississippi River and its tributaries, but there were no floods except along the upper Yazoo watershed which was visited by a flood that for duration and height, considering the season of the year, was really remarkable. It was due to excessive rains over the headwaters of the Yazoo River from November 17 to 21, inclusive, supplemented by other heavy rains over northern Mississippi during the month of December. In the vicinity of Swanlake, Tallahatchie County, the river was above the flood stage of 24 feet from November 25 until after the close of the year. The maximum stage of 29.3 feet, which was the highest on record, was reached on December 2. Several thousand acres of cultivated lands in Tallahatchie and Leflore counties were under water from two to four weeks, and much unpicked cotton rotted in the fields. Some stock was lost in Quitman County, and the streets of several towns in adjoining counties were covered with water for several days.

Warnings were issued on the 16th for a moderate flood stage in the lower Wabash River, and on the 21st for moderately high stages in the lower Ohio. These warnings were verified within a small fraction of a foot, and resulted in the saving of corn, logs, and musselshells valued at thousands of dollars.

There was also a local flood in the Middle Trinity River of Texas from the 22d to the 28th, inclusive, due to excessive rainfall on the 15th and 16th. The flood was limited to the vicinity of Long Lake, Tex., and attention to the warnings issued prevented any damage. The highest stage reached at Long Lake was 40.4 feet, 5.4 feet above the flood stage.

Heavy rains over the valley caused two decided rises in the Sacramento River during the month, but flood stages were not reached except at Colusa, Cal., where the flood stage of 25 feet was exceeded by 0.2 foot on the 28.

The Missouri River closed at Pierre, S. Dak., on the 13th, but at the end of the month it was still practically open at Sioux City, Iowa. The Mississippi closed at Leclaire, Iowa, on the 21st, but was still open at Davenport, Iowa, at the end of the month. On both rivers conditions were quite similar to those of December, 1905. Floating ice first appeared at St. Louis, Mo., on the 20th, and on the following day navigation between St. Louis, Mo., and Cairo, Ill., was suspended. Ice appeared in the Mississippi River at Cairo on the 24th, but none was reported south of that place. Tne larger eastern rivers, except those of New Fngland, remained open.

The highest and lowest water, mean stage, and monthly range at 289 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

THE WEATHER OF THE MONTH.

By Mr. P. C. DAY, Assistant Chief, Division of Meteorological Records.

PRESSURE.

The distribution of mean atmospheric pressure for December, 1906, over the United States and Canada is graphically shown on Chart VI, and the average values and departures from the normal are shown for each station in Tables I and V.

During December, 1906, the distribution of mean pressure showed several marked variations from the normal. The ridge of high mean pressure that usually extends from the south Atlantic coast northwesterly to the middle and northern Plateau districts, with the crest, about 30.20 inches, over southern Idaho, was largely replaced in the region west of the Mississippi Valley by comparatively low pressure. The ridge of highest mean pressure for the month extended from the South Atlantic and east Gulf States northwesterly over the Lake region, upper Mississippi Valley, North Dakota, and into the Canadian provinces of Manitoba and western Ontario, with the crest apparently north of the field of observation. The unusual persistence and strength of the great anticyclonic area that prevailed in the region north of the Great Lakes was conducive to the projection southward of numerous areas of high pressure which, spreading over the Dakotas, upper Mississippi Valley, Lake region, and thence eastward, gave to those districts rapid and severe changes in weather conditions.

Areas of high pressure were markedly absent from the districts west of the Rocky Mountains and over the middle and southern slope regions. The average pressure during the month exceeded the normal over nearly all parts of the United States and Canada, and was decidedly above the average along the northern border and in the Canadian districts from Manitoba to the St. Lawrence River and northward toward Hudson Bay, where the monthly averages exceeded the normal from 0.20 to 0.25 inch.

A slight deficiency in pressure, less than .05 inch, was general over the middle Plateau and central Pacific districts.

An unusual number of low pressure areas developed on the Pacific coast, that of the 10th being especially severe over the entire coast, with unusually high winds in the vicinity of San Francisco. In the presence of the extensive area of high pressure along the northern boundary, the paths of the lows eastward from the Rocky Mountain region were generally south of their normal tracks.

TEMPERATURE.

The temperature during December, 1906, averaged below the normal along the entire northern border from the Rocky Mountains eastward to the Atlantic. Over eastern Montana, North Dakota, northwestern Minnesota, and the greater part of New England the temperature during the first two decades of the month was unusually low, due to the rapid succession of areas of high pressure over those districts. The temperature was also below normal over the Florida Peninsula, especially in the central and southern districts, where phenomenally cold weather prevailed from the 23d to 27th, with frost and freezing weather nearly to the southern limit of the State.

A slight deficiency existed in the Sacramento Valley of California, due probably to the effect of air drainage from the surrounding mountains which were heavily covered with snow.

From the lower Mississippi Valley westward, over Texas, the middle and southern Rocky Mountain districts, and the whole of the Plateau region the month was unusually warm, the average excess ranging from 4° to 8° daily above the normal. No severe cold waves occurred over this extensive region and the temperature, with but few short exceptions, was continuously above the average.

Maximum temperatures of 80°, or higher, were confined to a small area of southern Texas and portions of southwestern Arizona and southern California. Over the northern portions of North Dakota, Minnesota, Wisconsin, and Michigan the maximum temperature did not reach 40°.

Minimum temperatures from 20° to 40° below zero were recorded in North Dakota and northern Minnesota on the 10th, and again on the 17th, and from 20° to 30° below zero over northern New England on the 12th and 19th.

Aside from the above-mentioned districts, minimum temperatures were not unusually low in any part of the United States except over central and southern Florida.

PRECIPITATION.

The precipitation was less than average over the South

Atlantic and Gulf States, central Texas, Oklahoma, Kansas, eastern Colorado, the middle Plateau district, and over the western portions of Washington and Oregon. Along the south Atlantic coast, over Florida, and the southern portions of the Gulf States the precipitation was very light. The amount of fall over the Florida Peninsula was less than 15 per cent of the normal, and the lack of moisture, especially in the central and northern counties of the State, as already noted in October and November, continued to the end of the year.

Over the districts near the coasts of Washington and Oregon the precipitation was from 2 to 4 inches less than the normal. Slight deficiences also occurred in the upper Mississippi Valley, near Lake Michigan, and generally over New York.

Precipitation was above the normal over the lower Ohio and middle Mississippi valleys, where marked excesses occurred in November. Amounts in excess of the average occurred over north-central and western Texas and over the entire upper Missouri Valley, the northern slope and Plateau districts, California, and the greater part of Arizona and New Mexico. Over practically all of California the month was an unusually wet one, the amounts in numerous cases exceeding the average by more than 10 inches.

Over northern and central Arizona the precipitation was unusually heavy, the amounts recorded at several points exceeding any previous December record.

SNOWFALL.

Measureable amounts of snowfall were recorded in all portions of the United States, except in a narrow strip along the south Atlantic and Gulf coasts, in southwestern Arizona and along the coast and on the lower elevations of California. The monthly amounts were generally above the normal over the upper Missouri Valley and over the entire Plateau region from northern Arizona to the northern boundary, including the western slopes of the Rocky Mountains and the higher elevations of the Sierras.

Snow was generally heavy over New England, the average fall ranging from one to three feet in the more northern portions. Heavy snow was also general over the mountain regions of northern and central California and extended unusually far down the slopes.

Over the eastern slopes of the Rocky Mountains from Wyoming south, and thence eastward to the Atlantic coast, the snowfall was generally less than the average and but little snow remained on the ground at any time during the month.

At the end of the month only the northern portions of New England and New York, the upper Lake region, upper Mississippi and Missouri valleys, and the high elevations of the western mountain and Plateau regions were snow covered. In northern New England depths from 10 to 26 inches prevailed, while over the eastern part of Montana, North Dakota, and the northern portions of Minnesota, Wisconsin, and Michigan depths from 5 to 30 inches remained on the ground.

Considerable snow had also accumulated on the western slopes of the Rocky Mountain districts and in the mountains of California.

HUMIDITY AND CLOUDINESS.

Cloudy weather and high humidity were general in all districts, except in the South Atlantic and Gulf States, where there was considerable sunshine and the moisture in the atmosphere was somewhat less than normal.

In Canada.—Prof. R. F. Stupart says:

The temperature was just average in the extreme southwestern portion of Ontario, also in Prince Edward Island and very locally in New Brunswick; elsewhere it was everywhere below the average and generally to a marked extent. The most noticeable negative departures were: Saskatchewan and Alberta, from 4° to 8°; Manitoba, 3°; the greater portion of Ontario, from 3° to 6°, and Quebec, from 2° to 5°.

The precipitation was above the average in Manitoba, also in nearly all portions of the Maritime Provinces, whilst in the other provinces it was in excess of the average in some localities and deficient in others. A few of the noticeable features of its distribution were the large positive departures over Nova Scotia and Cape Breton, the excessive snowfalls in Cariboo and more locally in northern Saskatchewan, and the marked negative departures again occurring in Ontario north and east of Lake Ontario to the boundary. The deficiency was well marked over a large portion of British Columbia.

At the close of the month snow was general over most of British Columbia; even at New Westminster 5 inches lay on the ground. In the Western Provinces a deep covering was the rule, northern Alberta recording 21 inches, Saskatchewan from 12 to 24 inches, and Manitoba from 7 to 12 inches. In Ontario, owing to the mild weather prevailing during the last week of the month, very little snow was left on the ground at the close of the year, except in northern localities; this was also the case in many portions of the Maritime Provinces, whilst in Quebec the depth was from 14 to 21 inches.

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England	9	25.7	— 4.1	+ 3.1	+ 0.3
Middle Atlantic	13	35.2	— 0.5	+12.6	+ 1.0
South Atlantic	10	48.4	+ 0.5	+ 5.7	+ 0.5
Florida Peninsula*	8	61.0	+ 0.1	+ 2.1	+ 0.2
East Gulf	8	52.7	+ 3.0	— 0.6	0.0
West Gulf	7	53.3	+ 3.6	+ 0.1	0.0
Ohio Valley and Tennessee	12	38.4	+ 0.7	+ 5.5	+ 0.5
Lower Lake	8	27.0	— 1.5	+12.5	+ 1.0
Upper Lake	10	24.1	— 0.5	+21.6	+ 1.8
North Dakota*	8	8.7	— 2.9	+22.1	+ 1.8
Upper Mississippi Valley	13	28.8	+ 1.2	+ 9.6	+ 0.8
Missouri Valley	11	29.8	+ 0.9	+11.2	+ 0.9
Northern Slope	7	26.8	+ 2.0	+11.1	+ 0.9
Middle Slope	6	38.8	+ 3.9	+ 2.0	+ 0.2
Southern Slope*	6	45.6	+ 4.6	—13.1	— 1.1
Southern Plateau*	13	43.5	+ 2.9	+ 1.8	+ 0.2
Middle Plateau*	8	30.7	+ 5.5	+ 2.5	+ 0.2
Northern Plateau*	12	33.3	+ 3.0	+20.6	+ 1.7
North Pacific	7	42.6	+ 0.7	+14.4	+ 1.2
Middle Pacific	5	48.3	— 0.3	+11.8	+ 1.0
South Pacific	4	53.5	+ 0.8	+ 9.0	+ 0.8

* Regular Weather Bureau and selected cooperative stations.

Average precipitation and departures from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		*Inches.*	*Inches.*
New England	9	3.89	115	+0.5	—1.8
Middle Atlantic	13	3.06	94	—0.2	+0.2
South Atlantic	10	2.50	75	—0.9	—4.6
Florida Peninsula*	8	0.58	22	—2.1	+2.4
East Gulf	8	3.77	84	—0.7	—0.2
West Gulf	7	2.63	90	—0.3	—8.3
Ohio Valley and Tennessee	12	4.20	114	+0.5	—3.0
Lower Lake	8	3.26	114	+0.4	—2.4
Upper Lake	10	2.20	96	—0.1	—1.7
North Dakota*	8	1.03	194	+0.5	+2.6
Upper Mississippi Valley	13	2.01	105	+0.1	—0.3
Missouri Valley	11	1.01	100	0.0	+1.3
Northern Slope	7	1.33	182	+0.6	+3.7
Middle Slope	6	0.37	43	—0.5	+2.1
Southern Slope*	6	0.64	51	—0.6	+4.2
Southern Plateau*	13	2.57	265	+1.6	+5.2
Middle Plateau*	8	1.34	129	+0.3	+4.7
Northern Plateau*	12	2.59	145	+0.8	+0.5
North Pacific	7	7.03	83	—1.4	—6.7
Middle Pacific	5	6.59	138	+1.8	+2.6
South Pacific	4	4.36	142	+1.3	+6.6

* Regular Weather Bureau and selected cooperative stations.

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
	%			%	
New England	77	+ 1	Missouri Valley	79	+ 4
Middle Atlantic	76	+ 1	Northern Slope	78	+ 9
South Atlantic	76	— 2	Middle Slope	70	+ 4
Florida Peninsula	78	— 4	Southern Slope	75	+10
East Gulf	78	+ 1	Southern Plateau	67	+19
West Gulf	79	+ 5	Middle Plateau	77	+ 6
Ohio Valley and Tennessee	80	+ 4	Northern Plateau	82	+ 5
Lower Lake	82	+ 4	North Pacific	87	+ 1
Upper Lake	82	0	Middle Pacific	84	+ 3
North Dakota	84	+ 7	South Pacific	76	+ 7
Upper Mississippi Valley	84	+ 6			

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Block Island, R. I.	1	57	nw.	New York, N. Y.	26	54	nw.
Do	2	60	nw.	North Head, Wash.	4	53	se.
Do	3	56	nw.	Do	6	88	se.
Do	4	56	nw.	Do	7	52	w.
Do	7	62	nw.	Do	10	94	se.
Do	8	61	nw.	Do	18	52	se.
Buffalo, N. Y	2	51	sw.	Do	22	56	se.
Do	6	76	sw.	Pittsburg, Pa.	6	52	w.
Canton, N. Y.	6	70	sw.	Point Reyes Light, Cal	10	92	s.
Cape Henry, Va	3	56	nw.	Do	25	80	sw.
Cleveland, Ohio	6	59	w.	Do	31	82	nw.
Do	7	54	nw.	Sacramento, Cal.	10	52	se.
Columbus, Ohio	6	58	w.	San Francisco, Cal	10	53	sw.
Duluth, Minn.	13	50	ne.	Seattle, Wash	6	60	sw.
Mount Tamalpais, Cal	1	52	ne.	Do	10	63	s.
Do	10	69	se.	Do	11	57	s.
Do	30	51	nw.	Southeast Farallon, Cal.	10	76	s.
Mount Weather, Va.	1	56	nw.	Do	25	62	s.
Do	3	62	nw.	Do	31	64	nw.
Do	7	56	nw.	Tatoosh Island, Wash	6	72	s.
Do	23	52	nw.	Do	7	86	sw.
Do	24	50	nw.	Do	10	70	e.
Do	25	73	nw.	Do	11	72	sw.
Do	26	66	nw.	Do	21	50	e.
New York, N. Y	1	54	w.	Do	25	54	e.
Do	2	51	nw.	Do	26	58	e.
Do	7	58	w.	Toledo, Ohio	6	57	w.

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	7.4	+ 1.6	Missouri Valley	6.8	+ 1.7
Middle Atlantic	7.1	+ 1.7	Northern Slope	6.4	+ 1.8
South Atlantic	5.3	+ 0.6	Middle Slope	4.7	+ 0.7
Florida Peninsula	3.5	— 1.1	Southern Slope	4.6	+ 0.2
East Gulf	5.8	+ 0.6	Southern Plateau	4.3	+ 1.3
West Gulf	6.0	+ 0.7	Middle Plateau	6.1	+ 1.0
Ohio Valley and Tennessee	7.8	+ 1.7	Northern Plateau	8.4	+ 1.3
Lower Lake	8.7	+ 1.1	North Pacific	8.2	+ 0.9
Upper Lake	7.8	+ 0.7	Middle Pacific	6.7	+ 1.3
North Dakota	6.6	+ 1.4	South Pacific	5.8	+ 1.4
Upper Mississippi Valley	7.4	+ 1.7			

CLIMATOLOGICAL SUMMARY.

By Mr. JAMES BERRY, Chief of the Climatological Division.

TEMPERATURE AND PRECIPITATION BY SECTIONS, DECEMBER, 1906.

In the following table are given, for the various sections of the Climatological Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observation. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—in degrees Fahrenheit.								Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
Alabama	50.3	+ 4.6	Citronelle	83	3	Valley Head	10	24	4.19	−0.47	Lincoln	6.46	Evergreen	2.36
Arizona	47.5	+ 2.1	Casagrande	87	9	Flagstaff (b)	2	30	3.65	+2.62	Pinal Ranch	9.69	Yuma	0.36
Arkansas	46.5	+ 4.1	Des Arc	83	3	Pond	10	23	5.64	+1.58	Helena (No. 2)	9.76	Pond	1.15
California	47.3	+ 0.7	Craftonville Ojai Valley	90 90	6, 21 21	Truckee	−12	31	8.42	+3.88	Helen Mine	28.26	Barstow	T.
Colorado	32.0	+ 7.0	Lamar	76	7	Antelope Springs	−32	16, 17	0.60	−0.33	Pagosa Springs	3.48	10 stations	0.00
Florida	59.3	0.0	Madison	89	6	Fort Meade	14	25	1.17	−1.74	Wausau	9.55	3 stations	0.00
Georgia	49.2	+ 2.9	Blakely	89	17	Clayton Washington	11 11	25 24	3.53	−0.57	Clayton	7.70	Waycross	0.34
Hawaii	70.5†	......	3 stations	89	4 dates	Tantalus, Oahu	50	30	15.12‡	......	Makawao, Maui	42.44	Mana Pump, Kauai	2.78
Idaho	32.8	+ 4.4	Hotspring	61	8	Chesterfield	−11	1	2.94	+1.05	Landore	8.49	Salmon	0.85
Illinois	32.7	+ 2.7	Equality	71	5	Tiskilwa	− 2	23	3.09	+0.87	Raum	8.89	Antioch	1.15
Indiana	33.8	+ 1.7	Mount Vernon	71	5	Plymouth	− 8	24	4.20	+1.27	Paoli	7.80	Hammond	1.89
Iowa	25.7	+ 2.7	4 stations	65	5, 12	Washta	− 9	18	1.43	+0.18	Independence	2.81	Estherville	0.37
Kansas	37.4	+ 4.6	Oswego	76	4	Harrison Norton	1 1	18 18	0.70	−0.29	Fort Scott	2.65	2 stations	T.
Kentucky	39.0	+ 2.3	Manchester	76	15	Williamsburg	− 9	27	5.64	+1.78	Blandville	7.22	Williamstown	3.35
Louisiana	56.6	+ 5.2	St. Francisville	88	3	Opelousas	19	24	4.10	−0.64	St. Francisville	6.25	Franklin	1.69
Maryland and Delaware	35.7	+ 0.9	Millsboro, Del.	72	15	Grantsville, Md	0	19	4.11	+0.80	Oakland, Md	7.16	2 stations	1.84
Michigan	25.2	− 0.4	Carsonville Dundee	59 59	4 6	Humboldt	−24	18	2.57	+0.34	Hagar	6.22	Omer	0.50
Minnesota	15.9	+ 0.6	3 stations	53	3 dates	Hallock	−36	17	0.91	+0.12	Leech Lake Dam	2.48	Worthington	0.15
Mississippi	51.8	+ 3.9	3 stations	83	3	Ripley	15	25	4.40	−0.30	Austin	8.97	Bay St. Louis	1.74
Missouri	36.1	+ 3.5	4 stations	73	3 dates	Steffenville Unionville	0 0	23 18	2.27	+0.02	Sikeston	8.87	2 stations	0.56
Montana	24.5	− 0.5	2 stations	65	3, 11	Lamedeer	−40	18	1.37	+0.68	Saltese	5.40	Ericson	0.18
Nebraska	30.9	+ 3.5	Fairmont Imperial	69 69	4 2	Winnebago	− 8	18	1.04	+0.30	Halsey	3.97	Haigler	T.
Nevada	33.5	+ 2.8	Wadsworth	74	26	McAfees Ranch	−21	6	1.91	+0.83	Lewers Ranch	7.90	Beowawe	0.39
New England*	22.7	− 4.2	6 stations	55	4 dates	Van Buren, Me	−30	9	3.59	+0.40	Kingston, R. I.	5.82	Norfolk, Mass	1.87
New Jersey	33.0	− 0.5	Indian Mills Toms River	70 70	15 15	Layton	− 5	19	3.99	+0.34	Newark	6.18	Mahwah	2.70
New Mexico	40.0	+ 5.0	Cliff	78	10	Red River	− 6	29	1.71	+0.98	Luna	5.72	Hope	T.
New York	23.8	− 2.3	Oyster Bay	62	1	Indian Lake Paul Smiths	−27 −27	12 8	3.15	+0.07	Cutchogue	5.77	West Berne	0.99
North Carolina	43.8	+ 1.9	Washington	86	7	Buck Spring	−15	25	3.52	−0.28	Horse Cove	7.67	Kinston	1.34
North Dakota	8.4	− 4.4	Fort Yates	51	2	McKinney	−40	10	1.07	+0.64	Fullerton	1.89	Wishek	0.20
Ohio	32.3	+ 1.2	Green Ironton	68 68	14 14	Cardington	−15	24	3.68	+0.94	Marietta	5.33	Philo	1.90
Oklahoma and Indian Territories.	44.3	+ 5.2	Pauls Valley, Ind. T.	82	3	Hooker, Okla.	6	17	1.13	−0.43	South McAlester, Ind. T.	3.23	Taloga, Okla.	0.10
Oregon	39.6	+ 2.6	Gold Beach	69	1	Granite	− 8	31	5.95	+0.09	Nehalem	19.90	Prineville	0.53
Pennsylvania	30.8	− 0.3	Irwin	67	31	Lewisburg	−14	19	3.97	+0.61	Confluence	7.08	Skidmore	1.69
Porto Rico	72.6	......	Central Aguirre Coloso	95 95	1 4	Cidra	52	29	8.11	......	Manati	22.62	Guanica Central	0.25
South Carolina	48.0	+ 1.0	Blackville	89	14	Dillon	11	26	3.25	+0.18	Walhalla	7.71	Winnsboro	1.18
South Dakota	21.0	− 0.3	Hermosa	72	2	Frederick	−25	18	0.76	+0.16	Frederick	2.26	Kidder	0.12
Tennessee	43.0	+ 3.8	Dover	74	5	Rugby	− 4	24	5.52	+1.02	Dyersburg	8.08	Rogersville	3.25
Texas	54.3	+ 5.3	Fort McIntosh	90	10	Henrietta	14	18	2.11	+0.17	Jefferson	7.67	4 stations	0.00
Utah	33.3	+ 6.2	Rockville	76	8	Woodruff	−12	15	1.63	+0.63	Grayson	4.15	Trout Creek	0.15
Virginia	38.9	+ 1.0	Arvonia Doswell	73 73	15 15	Elk Knob	1	24	3.09	−0.01	Speers Ferry	6.23	Hampton	1.19
Washington	36.1	+ 0.7	Pomeroy	66	21	Twisp	− 9	14	6.13	+0.11	Yale	19.37	Ephrata	0.96
West Virginia	35.9	+ 1.9	Charleston Moorfield	70 70	14 13	Parsons	− 1	26	4.73	+1.04	Terra Alta	11.15	New Cumberland	1.83
Wisconsin	22.6	+ 3.2	Whitehall	53	5	Hayward	−26	7	1.64	+0.32	Sturgeon Bay	3.60	Hancock	0.20
Wyoming	28.2	+ 5.3	Pine Bluff Sheridan	67 67	22, 23 3	Wells	−30	15	1.06	+0.10	Lake, Y. N. P.	4.80	Pine Bluff	T.

* Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. † 43 stations, with an average elevation of 541 feet. ‡ 139 stations.

DESCRIPTION OF TABLES AND CHARTS.

By Mr. P. C. DAY, Assistant Chief, Division of Meteorological Records.

For description of tables and charts see page 38 of REVIEW for January, 1906.

TABLE I.—*Climatological data for U. S. Weather Bureau stations, December, 1906.*

Stations.	Elevation of instruments. Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Temperature of the air, in degrees Fahrenheit. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches. Total.	Departure from normal.	Days with .01, or more.	Wind. Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
New England.							25.7	− 4.1										77	3.89	+ 0.5										7.4	
Eastport	76	69	85	29.94	30.03	+ .04	23.2	− 2.3	48	21	31	− 9	8	16	44	21	17	79	5.13	+ 1.2	14	9,663	nw.	42	ne.	11	3	9	19	7.9	35.0
Portland, Me.	103	81	117	29.96	30.09	+ .06	22.2	− 5.2	47	1	29	− 4	8	15	34	20	14	73	4.80	+ 1.3	12	6,764	nw.	40	nw.	4	6	6	19	6.8	24.9
Concord	288	70	79	29.97	30.11	+ .05	21.0	− 5.0	45	1	30	−11	19	12	42	.....	.....	.....	3.20	− 0.1	8	3,934	nw.	28	nw.	2	8	4	19	6.7	16.0
Burlington	404	12	47	29.67	30.15	+ .10	17.2	− 7.9	45	6	25	−12	12	9	34	.....	.....	.....	1.99	+ 0.1	14	8,942	nw.	49	s.	15	2	6	23	8.3	17.9
Northfield	876	16	70	29.13	30.13	+ .08	14.7	− 6.7	48	6	25	−22	12	4	43	13	11	86	3.43	+ 0.7	11	5,767	n.	42	nw.	1	2	5	24	8.6	22.5
Boston	125	115	188	29.95	30.09	+ .04	29.1	− 2.0	54	6	37	1	8	22	44	27	21	72	3.96	+ 0.5	15	7,811	nw.	36	nw.	2	5	9	17	7.1	15.5
Nantucket	12	14	90	30.06	30.07	+ .02	33.2	− 3.2	52	6	40	7	8	27	37	31	28	82	4.58	+ 0.4	15	12,001	nw.	44	w.	1	2	10	19	7.8	4.3
Block Island	26	11	46	30.06	30.08	+ .02	32.9	− 3.3	55	6	40	5	8	26	38	30	26	76	3.51	− 0.2	12	15,243	nw.	62	nw.	7	4	12	15	6.9	1.4
Narragansett	.....	9	.....	.....	.....	.....	29.8	− 3.0	53	6	39	2	8	20	39	.....	.....	.....	4.22	+ 0.5	16	.....	w.	.....	.....	..	8	5	18	.....	7.0
Providence	160	57	67	29.92	30.10	+ .04	28.9	− 4.3	55	6	37	0	8	21	45	26	20	73	3.81	.....	14	5,504	nw.	29	nw.	1	5	10	16	7.2	9.0
Hartford	159	122	132	29.93	30.12	+ .05	27.2	− 3.2	51	6	34	0	8	20	43	25	20	76	3.83	.....	15	4,652	n.	31	nw.	7	5	7	19	7.7	13.1
New Haven	106	116	155	29.99	30.11	+ .04	29.4	− 2.8	54	31	37	3	8	22	40	27	21	72	4.18	+ 0.8	12	7,662	ne.	33	nw.	7	8	6	17	6.4	9.1
Mid. Atlantic States.							35.2	− 0.5										76	3.06	− 0.2										7.1	
Albany	97	102	115	30.04	30.15	+ .07	24.5	− 4.1	48	6	32	− 2	8	17	33	23	20	84	1.96	− 0.8	12	6,042	nw.	25	s.	15	2	8	21	8.2	6.7
Binghamton	875	79	90	29.15	30.12	+ .03	26.1	− 1.5	51	6	33	1	24	19	25	.....	.....	.....	2.44	− 0.1	16	5,270	n.	30	sw.	6	2	5	24	8.5	6.2
New York	314	108	350	29.76	30.12	+ .03	32.7	− 1.7	57	15	40	8	24	26	40	30	26	77	3.53	+ 0.2	13	10,772	nw.	58	w.	7	6	9	16	6.9	0.5
Harrisburg	374	94	104	29.74	30.16	+ .04	31.2	− 3.2	56	6	37	10	24	25	26	28	24	75	3.34	+ 0.3	14	6,284	nw.	40	nw.	1	4	8	19	7.4	3.4
Philadelphia	117	116	184	30.00	30.14	+ .03	35.3	− 0.2	62	15	43	11	24	28	35	32	26	69	3.07	+ 0.3	15	9,062	nw.	41	nw.	3	6	6	19	7.3	0.2
Scranton	805	111	119	29.23	30.13	+ .03	28.8	.....	53	6	36	3	24	22	30	26	23	80	3.28	.....	23	5,645	sw.	28	nw.	1	2	5	24	8.4	8.8
Atlantic City	52	37	48	30.07	30.13	+ .03	36.2	− 0.2	54	31	43	10	24	29	33	32	28	74	3.67	− 0.2	13	6,906	nw.	31	nw.	3	5	8	18	7.2	T.
Cape May	17	48	52	30.14	30.16	+ .05	37.2	− 0.7	54	7	44	13	24	31	31	34	.....	.....	3.72	− 0.1	15	8,117	nw.	.....	.....	..	4	15	12	6.7	T.
Baltimore	123	69	117	30.00	30.14	+ .01	36.3	− 1.2	68	6	44	13	25	29	31	32	26	69	4.06	+ 0.9	14	5,949	nw.	38	nw.	7	5	7	19	7.2	0.2
Washington	112	59	76	30.03	30.16	+ .03	37.0	+ 0.8	69	15	45	13	25	29	32	33	28	74	3.23	+ 0.2	14	5,342	nw.	34	nw.	7	6	7	18	7.1	0.3
Cape Henry	18	11	58	30.12	30.14	+ .02	43.4	− 0.5	72	6	51	18	25	36	29	.....	.....	.....	3.12	− 0.8	14	12,601	s.	56	nw.	3	8	12	11	6.1	2.4
Lynchburg	681	83	88	29.40	30.16	+ .02	40.6	+ 1.3	72	15	49	18	25	32	32	36	31	73	2.92	− 0.1	11	3,860	sw.	26	nw.	3	7	13	11	6.2	0.4
Mount Weather	1,725	10	57	28.25	30.15	+ .02	31.7	.....	63	15	40	5	25	24	30	29	26	83	3.52	.....	13	15,016	nw.	73	nw.	25	6	9	16	7.0	2.6
Norfolk	91	102	111	30.06	30.16	+ .03	43.7	+ 0.9	71	6	52	16	25	35	30	39	34	71	2.97	− 0.7	14	7,710	s.	36	n.	11	9	7	15	6.0	T.
Richmond	144	145	153	30.01	30.17	+ .03	41.4	+ 0.4	70	15	50	14	25	33	33	.....	.....	.....	2.12	− 1.3	8	7,266	s.	45	s.	6	8	6	17	6.7	T.
Wytheville	2,293	40	47	27.72	30.18	+ .03	37.1	+ 2.4	63	15	45	10	26	30	29	33	30	82	1.96	− 0.8	12	5,162	w.	30	w.	7	5	11	15	6.8	3.0
S. Atlantic States.							48.4	+ 0.5										76	2.50	− 0.9										5.3	
Asheville	2,255	53	75	27.78	30.21	+ .05	39.8	+ 0.2	68	6	48	7	24	31	33	37	35	87	1.91	− 1.0	12	6,973	nw.	36	nw.	7	10	5	16	6.0	1.3
Charlotte	773	68	76	29.34	30.20	+ .04	44.8	+ 1.2	70	3	53	17	24	37	28	40	35	75	3.31	− 0.8	11	6,225	sw.	26	s.	31	11	3	17	6.0	T.
Hatteras	11	12	47	30.15	30.16	+ .03	48.2	0.0	71	6	56	20	25	41	28	45	42	82	3.71	− 1.8	10	12,958	sw.	49	n.	11	8	11	12	5.9	T.
Raleigh	376	71	79	29.77	30.19	+ .04	44.4	+ 0.5	72	17	54	17	25	35	31	39	32	69	2.92	− 0.2	12	5,743	sw.	28	nw.	7	9	8	14	6.2	T.
Wilmington	78	81	91	30.11	30.20	+ .05	47.8	− 0.5	73	16	57	20	25	39	31	42	37	71	3.37	+ 0.4	9	5,938	sw.	32	sw.	6	11	12	8	4.6	
Charleston	48	14	92	30.16	30.21	+ .06	51.8	+ 0.3	75	3	60	22	25	44	23	46	42	76	1.83	− 1.4	9	7,769	sw.	32	w.	3	12	10	9	4.8	
Columbia, S. C.	351	41	57	29.81	30.21	+ .05	48.7	+ 0.8	74	3	58	17	25	40	31	43	37	73	2.56	− 0.4	9	3,925	sw.	36	sw.	6	10	9	12	6.0	
Augusta	180	89	97	30.01	30.21	+ .05	49.6	+ 1.9	74	3	59	20	25	40	33	44	40	77	2.47	− 0.9	9	4,914	nw.	28	w.	3	10	9	12	5.6	T.
Savannah	65	81	89	30.15	30.22	+ .07	52.6	+ 0.2	76	17	61	22	25	44	27	46	41	73	1.81	− 1.4	7	5,981	sw.	34	w.	3	14	7	10	4.6	
Jacksonville	43	101	129	30.17	30.22	+ .08	56.0	0.0	77	6	65	24	24	47	30	50	48	81	1.09	− 1.8	4	6,711	s.	30	sw.	6	17	8	6	3.6	
Florida Peninsula.							66.4	− 0.8										78	0.15	− 2.0										3.5	
Jupiter	28	10	48	30.15	30.18	+ .08	65.6	− 1.1	82	7	73	30	24	58	29	59	56	77	0.05	− 2.8	1	9,012	nw.	36	ne.	11	10	19	2	3.9	
Key West	22	10	53	30.14	30.16	+ .08	69.2	− 0.8	80	20	74	47	25	64	15	63	60	78	0.29	− 1.3	5	8,153	ne.	39	nw.	23	20	8	3	3.1	
Sand Key	25	41	71	30.12	30.15	+ .07	69.6	.....	79	7	72	48	24	67	11	.....	.....	.....	0.18	.....	3	14,651	ne.	49	nw.	23	16	13	2	3.3	
Tampa	35	79	96	30.18	30.22	+ .10	61.3	− 0.6	79	16	71	28	24	52	32	54	51	77	0.09	− 1.8	1	5,779	ne.	24	nw.	23	17	11	3	3.6	T.
East Gulf States.							52.7	+ 3.0										78	3.77	− 0.7										5.8	
Atlanta	1,174	190	216	28.94	30.21	+ .05	46.4	+ 1.1	69	14	54	16	24	39	27	42	37	74	4.51	+ 0.3	13	10,793	nw.	48	nw.	23	9	6	16	6.4	T.
Macon	370	55	66	29.82	30.22	+ .06	50.9	+ 4.6	77	6	60	20	24	42	34	.....	.....	.....	3.55	− 1.0	10	4,126	nw.	23	sw.	6	8	10	13	5.6	
Thomasville	273	8	57	29.92	30.23	+ .08	53.8	+ 1.5	78	3	65	22	27	42	37	47	44	82	2.06	− 1.9	8	4,401	s.	23	w.	22	18	4	9	3.9	
Pensacola	56	79	96	30.15	30.21	+ .06	57.4	+ 2.9	77	10	64	26	24	50	23	.....	.....	.....	2.70	− 1.2	9	7,801	n.	35	sw.	30	13	6	12	5.2	
Anniston	741	9	58	29.42	30.23	+ .07	47.9	+ 4.2	73	14	57	16	24	39	32	.....	.....	.....	6.05	+ 1.8	11	4,932	se.	23	e.	19	6	5	20	7.2	T.
Birmingham	700	136	144	29.45	30.23	+ .07	50.2	+ 2.0	71	14	57	19	24	43	27	46	42	78	4.62	− 0.5	10	7,100	n.	31	se.	30	7	10	14	6.6	T.
Mobile	57	98	106	30.14	30.21	+ .06	57.0	+ 4.6	78	3	65	27	24	50	25	52	48	77	2.44	− 2.0	7	6,401	n.	27	n.	18	10	9	12	5.4	
Montgomery	223	100	112	29.97	30.23	+ .07	52.1	+ 2.5	74	6	61	22	24	44	30	47	43	77	3.30	− 1.4	8	5,570	se.	28	se.	19	10	11	10	5.4	
Meridian	375	84	93	29.81	30.21	+ .05	53.2	+ 2.7	75	14	62	23	24	44	32	48	45	80	4.77	− 0.5	10	4,531	sw.	24	se.	10	8	9	14	6.2	T.
Vicksburg	247	63	74	29.93	30.22	+ .07	54.2	+ 3.6	79	3	62	27	24	46	27	49	45	76	4.15	− 0.8	10	5,128	se.	34	w.	30	6	12	13	6.1	0.2
New Orleans	51	88	121	30.15	30.20	+ .07	59.0	+ 3.5	79	13	66	30	24	52	24	54	51	82	3.36	− 1.0	10	6,850	n.	29	se.	14	5	13	13	6.1	
West Gulf States.							53.3	+ 3.6										79	2.63	− 0.3										6.0	
Shreveport	249	77	84	29.92	30.20	+ .07	53.2	+ 3.7	80	3	62	29	24	45	27	48	44	76	3.52	− 1.2	9	5,356	s.	23	ne.	15	11	7	13	5.7	
Bentonville	1,303	11	44	28.70	30.13	.00	42.0	.....	69	4	50	17	23	34	33	.....	.....	.....	1.81	.....	8	5,421	s.	24	s.	8	7	5	19	7.3	1.7
Fort Smith	457	79	94	29.68	30.17	+ .04	45.8	+ 3.0	75	3	54	26	18	38	29	42	38	77	3.55	+ 0.4	7	7,014	e.	38	nw.	6	8	6	17	6.6	
Little Rock	357	93	100	29.81	30.20	+ .06	48.0	+ 3.0	74	5	55	27	23	41	24	43	39	76	5.20	+ 0.9	8	6,201	s.	26	nw.	22	5	7	19	7.2	0.8
Corpus Christi	20	48	53	30.15	30.17	+ .05	62.4	+ 3.1	80	9	69	36	19	56	29	58	55	82	0.17	− 1.2	4	6,830	s.	25	ne.	7	15	6	10	4.8	
Fort Worth	670	106	114	29.45	30.18	+ .06	51.7	+ 4.8	79	9	61	26	18	43	32	.....	.....	.....	1.22	− 0.3	6	8,085	n.	35	sw.	8	10	14	7	5.1	
Galveston	54	106	112	30.13	30.19	+ .07	61.6	+ 4.5	75	5	66	39	19	57	21	59	57	88	1.63	− 2.4	10	8,365	se.	32	n.	6	8	12	11	5.6	
Palestine	510	73	79	29.62	30.17	+ .05	54.6	+ 3.2	78	3	63	31	18	46	27	49	45	76	5.40	+ 1.6	8	6,046	s.	28	ne.	15	7	4	20	6.7	1.4
San Antonio	701	80	91	29.42	30.16	+ .05	58.2	+ 3.3	78	9	67	33	18	49	33	52	48	76	1.60	− 0.3	7	5,018	se.	23	n.	15	8	10	13	5.9	T.
Taylor	583	55	63	29.55	30.17	+ .06	55.3	.....	80	3	65	30	19	46	36	.....	.....	.....	2.19	.....	7	6,361	n.	28	sw.	13	9	11	11	5.3	T.
Ohio Val. and Tenn.							38.4	+ 0.7										80	4.20	+ 0.5										7.8	
Chattanooga	762	106	112	29.40	30.24	+ .08	45.3	+ 1.7	69	6	52	17	24	38	30	41	38	77	3.75	− 0.6	16	5,420	se.	30	sw.	30	8	4	19	6.5	0.1
Knoxville	1,004	35	88	29.13	30.21	+ .05	41.4	+ 1.5	68	6	49	13	24	34	30	38	34	79	3.57	− 0.5	14	5,986	sw.	38	sw.	6	7	5	19	7.2	0.2
Memphis	399	76	97	29.78	30.22	+ .07	46.4	+ 2.8	72	5	53	24	23	40	34	40	37	80	5.20	+ 1.0	11	6,944	s.	38	sw.	30	7	8	16	6.8	0.2
Nashville	546	79	91	29.63	30.23	+ .08	44.4	+ 2.7	69	14	51	19	26	37	31	40	37	77	5.11	+ 1.4	16	5,239	nw.	32	sw.	6	6	4	21	7.4	T.
Lexington	989	75	102	29.10	30.21	+ .07	36.4	− 2.2	62	14	43	8	24	28	31	.....	.....	.....	4.54	+ 1.1	18	8,930	s.	37	nw.	6	6	4	21	8.1	3.8
Louisville	525	111	132	29.61	30.21	+ .07	39.2	+ 0.8	66	5	46	16	23	32	35	37	34	85	5.02	+ 1.2	17	6,794	s.	38	w.	6	4	6	21	7.2	1.3
Evansville	431	72	82	29.70	30.18	+ .05	38.8	.....	68	5	45	16	23	33	32	.....	.....	.....	5.72	.....	15	6,240	s.	36	w.	5	4	10	17	7.3	2.2
Indianapolis	822	154	164	29.26	30.18	+ .06	34.2	+ 1.1	61	6	41	9	23	28	38	32	29	83	3.37	+ 0.2	14	7,707	nw.	44	se.	30	5	6	20	7.8	3.9
Cincinnati	628	152	160	29.50	30.20	+ .07	36.4	− 0.2	65	14	44	8	24	29	30	34	30	83	3.57	+ 0.2	14	5,362	sw.	28	w.	6	6	4	21	7.8	5.3
Columbus	824	173	190	29.27	30.17	+ .05	32.7	− 0.6	60	14	39	3	24	26	30	31	28	81	3.33	+ 0.4	18	9,550	nw.	48	sw.	6	2	9	20	8.1	4.3
Pittsburg	842	336	352	29.22	30.16	+ .05	33.2	− 1.8	61	31	40	9	25	26	30	31	28	80	2.52	− 0.4	21	8,342	w.	52	w.	6	1	2	28	9.2	7.4
Parkersburg	638	77	84	29.51	30.18	+ .04	36.4	− 0.2	64	14	44	11	24	29	29	34	31	81	3.82	+ 1.1	18	5,525	nw.	30	w.	6	1	5	25	8.7	5.1
Elkins	1,940	41	50	28.06	30.19	+ .07	34.6	+ 2.3	63	31	43	7	27	27	34	32	28	81	5.07	+ 0.9	20	3,521	w.	24	w.	6	2	5	24	8.6	8.1
Lower Lake Region.							27.0	− 1.5										83	3.26	+ 0.4										8.7	
Buffalo	767	178	206	29.26	30.12	+ .06	26.8	− 3.0	55	31	34	2	8	20	32	25	23	84	3.90	+ 0.5	24	11,232	n.	76	sw.	6	1	4	26	8.6	15.3
Canton	448	10	71	29.62	30.13	.....	14.4	.....	46	6	23	−19	8	5	45	.....	.....	.....	3.03	.....	20	8,135	ne.	70	sw.	6	2	7	22	8.0	19.8
Oswego	335	76	91	29.74	30.12	+ .06	24.6	− 4.8	48	6	31	− 8	18	18	33	23	21	87	2.99	− 0.4	20	9,463	s.	78	w.	6	0	2	29	9.5	17.7
Rochester	523	81	102	29.54	30.14	+ .08	26.2	− 2.4	56	31	33	2	8	20	33	24	22	83	2.45	− 0.5	19	6,850	nw.	48	w.	6	1	3	27	9.2	18.7
Syracuse	597	97	113	29.45	30.12	+ .05	23.9	− 1.5	51	6	31	− 7	8	17	29	.....	.....	.....	2.90	.....	18	8,412	nw.	49	w.	1	1	8	22	8.4	23.9
Erie	713	92	102	29.33	30.12	+ .05	30.9	− 1.5	58	15	38	11	25	24	31	28	24	83	3.31	+ 0.1	17	8,941	nw.	45	w.	6	1	4	26	9.1	6.5
Cleveland	762	190	201	29.29	30.14	+ .05	32.4	+ 1.2	58	6	39	13	19	26	32	30	26	78	3.68	+ 1.0	18	13,201	nw.	59	w.	6	0	2	29	9.4	10.7
Sandusky	629	62	70	29.43	30.14	+ .05	31.8	− 0.7	58	6	38	12	26	26	32	.....	.....	.....	3.10	+ 0.6	18	6,971	sw.	35	w.	6	1	5	25	8.7	4.1
Toledo	628	207	246	29.45	30.16	+ .08	30.1	− 0.6	56	14	36	3	24	24	33	28	25	83	3.49	+ 1.1	18	10,327	nw.	57	w.	6	2	9	20	7.8	6.6
Detroit	730	153	193	29.33	30.15	+ .08	29.0	− 0.5	50	14	35	8	24	23	30	27	24	83	3.77	+ 1.2	14	8,587	sw.	46	w.	6	1	9	21	8.1	7.1
Upper Lake Region.							24.1	− 0.5										82	2.20	− 0.1										7.8	
Alpena	609	13	92	29.46	30.16	+ .14	22.6	− 2.2	41	31	30	− 1	7	15	26	21	18	83	2.75	+ 0.3	14	8,997	nw.	37	e.	30	2	10	19	7.9	13.0
Escanaba	612	40	82	29.47	30.17	+ .14	22.2	+ 0.8	36	14	28	− 1	7	16	19	20	17	79	2.38	+ 0.3	12	8,285	nw.	43	ne.	30	8	9	14	6.5	13.7
Grand Haven	632	54	92	29.44	30.15	+ .10	28.8	− 0.8	48	31	35	12	24	23	21	26	23	82	2.26	− 0.4	11	9,141	n.	40	sw.	31	2	7	22	8.1	8.8

TABLE I.—*Climatological data for U. S. Weather Bureau stations, December, 1906*—Continued.

Stations.	Elevation of instruments. Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Temperature of the air, in degrees Fahrenheit. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches. Total.	Departure from normal.	Days with .01, or more.	Wind. Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
Up. Lake Reg—Cont.																															
Grand Rapids	707	121	162	29.36	30.16	+ .11	28.2	− 0.5	49	31	34	10	25	22	22	26	24	85	2.05	− 0.8	13	8,101	n.	33	w.	31	4	4	23	8.0	3.8
Houghton	668	66	74	29.39	30.15	+ .13	20.4	......	36	26	26	0	7	14	24	....	....	....	2.54	......	23	5,177	e.	25	w.	14	0	5	26	9.2	32.1
Marquette	734	77	116	29.33	30.17	+ .15	22.0	− 0.8	37	26	27	2	7	17	18	20	16	79	3.38	+ 0.9	19	8,944	w.	36	sw.	19	1	6	24	8.5	27.7
Port Huron	638	70	120	29.42	30.14	+ .08	26.7	− 1.1	50	31	33	6	7	21	27	26	23	85	2.64	+ 0.3	17	9,698	nw.	36	nw.	3	1	5	25	8.8	10.4
Sault Ste. Marie	614	40	61	29.45	30.19	+ .19	17.4	− 5.2	38	31	24	−16	7	10	27	16	12	81	1.79	− 0.3	14	7,444	e.	44	nw.	1	6	2	23	7.8	12.5
Chicago	823	140	310	29.24	30.16	+ .08	32.8	+ 3.5	56	14	38	10	7	27	39	30	28	83	2.46	+ 0.1	11	11,359	nw.	39	sw.	31	3	8	20	7.7	0.3
Milwaukee	681	122	142	29.41	30.18	+ .12	28.8	+ 3.2	45	14	35	4	7	23	21	26	24	85	1.39	− 0.6	8	8,863	sw.	44	e.	30	6	6	19	7.2	0.7
Green Bay	617	49	86	29.46	30.15	+ .11	24.1	+ 0.3	42	31	30	− 1	7	18	22	22	18	78	1.63	− 0.3	10	8,137	sw.	38	n.	3	4	8	19	7.2	5.1
Duluth	1,133	11	47	28.88	30.17	+ .12	14.8	− 2.2	33	13	22	−17	7	8	34	14	12	87	1.21	− 0.2	15	11,119	sw.	50	ne.	13	5	14	12	6.3	12.2
North Dakota.							8.2	− 3.2										84	1.02	+ 0.1										6.6	
Moorhead	940	8	57	29.14	30.22	+ .14	9.0	− 2.9	36	2	19	−18	10	−1	36	9	7	91	1.16	+ 0.4	10	7,091	n.	30	n.	6	5	8	18	7.0	13.8
Bismarck	1,674	8	57	28.32	30.22	+ .14	10.8	− 3.9	43	2	21	−27	17	0	41	9	6	81	0.64	0.0	7	6,550	nw.	33	nw.	14	9	4	18	6.6	7.0
Devils Lake	1,482	11	44	28.52	30.20	+ .14	2.5	......	36	2	14	−30	10	−9	45	2	−2	76	1.55	......	7	9,766	se.	42	ne.	12	8	5	18	6.6	16.7
Williston	1,875	14	44	28.06	30.16	+ .10	10.3	− 2.7	41	3	21	−37	17	0	40	8	6	86	0.73	0.0	6	6,306	n.	31	n.	31	6	12	13	6.4	7.3
Upper Miss. Valley.							28.3	+ 1.2										84	2.01	+ 0.1										7.4	
Minneapolis	......	102	208	......	......	......	20.1	0.0	42	29	28	−12	7	13	30	....	....	...	0.76	− 0.7	7	9,467	nw.	35	nw.	6	5	7	19	7.3	8.6
St. Paul	837	171	179	29.22	30.16	+ .08	20.7	+ 1.9	45	29	28	−11	7	13	29	19	15	80	0.79	− 0.5	7	8,169	n.	35	nw.	6	3	9	19	7.8	6.6
La Crosse	714	71	87	29.36	30.17	+ .09	24.2	+ 0.6	44	2	30	− 2	7	18	23	....	....	....	1.79	+ 0.4	8	5,954	s.	24	n.	22	7	5	19	7.2	4.7
Madison	974	70	78	29.06	30.17	+ .09	25.0	+ 2.3	41	4	31	1	7	19	25	23	21	86	1.23	− 0.5	8	8,199	nw.	33	ne.	30	6	8	17	6.9	1.6
Charles City	1,015	8	58	29.05	30.18	+ .08	22.6	+ 1.6	46	2	30	− 9	23	16	31	21	19	88	1.22	− 0.1	6	6,717	se.	32	nw.	6	5	6	20	7.5	4.5
Davenport	606	71	79	29.49	30.18	+ .08	29.2	+ 1.4	54	14	36	4	23	23	30	27	24	83	1.61	− 0.1	9	5,815	nw.	29	nw.	6	5	7	19	7.3	0.6
Des Moines	861	84	101	29.24	30.18	+ .07	28.1	+ 1.3	52	13	35	1	18	21	30	26	23	80	1.46	0.0	6	6,250	nw.	31	nw.	6	6	8	17	7.1	0.6
Dubuque	698	100	117	29.41	30.20	+ .10	26.8	+ 0.9	45	13	34	3	7	20	28	25	23	86	2.04	+ 0.2	10	5,483	s.	24	nw.	6	7	6	18	7.0	0.6
Keokuk	614	64	77	29.49	30.20	+ .08	31.6	+ 1.8	62	13	38	4	23	25	33	28	26	82	1.90	− 0.1	8	5,696	nw.	23	sw.	13	7	8	16	6.5	0.1
Cairo	356	87	93	29.82	30.21	+ .06	40.2	+ 1.0	70	5	46	17	23	34	29	38	36	85	6.50	+ 3.2	16	7,516	s.	34	sw.	5	2	5	24	8.5	0.8
La Salle	536	56	64	29.60	30.19	+ .10	30.5	......	56	5	38	8	23	24	42	....	....	....	2.14	......	8	6,026	w.	29	w.	6	5	7	19	7.2	0.3
Peoria	609	11	45	29.50	30.18	+ .07	30.6	......	58	5	38	3	24	24	40	28	26	85	1.65	......	10	6,914	s.	30	nw.	6	6	6	19	7.3	0.6
Springfield, Ill.	644	10	92	29.46	30.17	+ .05	33.0	+ 0.2	59	5	40	9	23	26	38	31	28	82	3.14	+ 0.4	11	6,775	s.	30	nw.	6	3	7	21	7.9	1.0
Hannibal	534	75	109	29.59	30.19	+ .07	32.9	+ 1.0	66	13	40	6	23	26	35	....	....	....	1.88	+ 0.2	12	6,372	nw.	29	sw.	12	6	2	23	7.6	1.4
St. Louis	567	208	217	29.55	30.18	+ .05	36.6	+ 1.0	63	5	44	10	23	30	38	34	32	85	2.09	− 0.7	10	8,001	se.	38	w.	6	4	6	21	7.9	1.6
Missouri Valley.							29.8	+ 0.9										79	1.01	0.0										6.8	
Columbia, Mo.	784	11	84	29.30	30.16	+ .04	35.2	+ 0.4	68	13	42	13	18	28	33	....	....	....	1.60	− 0.2	12	6,429	se.	28	sw.	13	6	3	22	7.6	0.3
Kansas City	963	78	95	29.14	30.21	+ .09	35.7	+ 3.8	67	5	43	10	18	28	29	33	29	78	1.62	+ 0.1	7	5,178	nw.	26	nw.	5	7	8	16	6.5	0.0
Springfield, Mo	1,324	98	104	28.72	30.17	+ .04	38.7	+ 0.1	69	9	46	13	18	31	31	36	33	82	1.50	− 1.1	9	8,706	se.	38	w.	6	6	6	19	7.0	2.5
Iola	984	40	47	29.11	30.20	+ .08	38.0	......	70	4	47	11	18	29	31	....	....	....	0.60	......	5	6,299	n.	34	sw.	13	6	5	20	7.2	
Topeka	......	85	89	......	......	......	35.4	+ 0.6	66	13	44	10	18	27	31	....	....	....	0.63	− 0.3	6	6,517	s.	31	s.	12	9	7	15	6.4	T.
Lincoln	1,189	11	84	28.84	30.16	+ .04	30.5	+ 0.1	57	28	39	4	18	22	32	27	22	73	0.83	+ 0.1	3	7,664	n.	32	nw.	6	8	7	16	6.3	0.3
Omaha	1,105	115	121	28.95	30.18	+ .07	29.0	+ 2.3	54	28	36	6	18	22	31	26	21	74	1.26	+ 0.2	4	6,981	s.	36	nw.	6	4	9	18	7.7	T.
Valentine	2,598	47	54	27.34	30.16	+ .06	28.3	+ 1.1	64	3	39	5	6	17	44	24	20	80	0.40	0.0	4	6,509	nw.	33	nw.	21	9	12	10	5.4	1.8
Sioux City	1,135	96	164	28.91	30.18	+ .06	25.0	+ 0.9	50	2	32	2	18	18	28	....	....	....	0.99	+ 0.1	5	9,966	nw.	47	nw.	13	6	7	18	7.1	0.6
Pierre	1,572	43	50	28.44	30.19	+ .09	19.2	− 0.9	60	2	28	− 8	10	10	36	16	13	81	0.84	+ 0.4	6	4,292	se.	25	n.	21	8	12	11	5.9	7.8
Huron	1,306	56	67	28.73	30.20	+ .10	18.4	− 0.8	59	2	27	− 7	10	9	39	16	14	84	0.69	+ 0.1	5	8,477	n.	38	nw.	6	8	5	18	7.1	2.6
Yankton	1,233	49	57	28.80	30.17	+ .06	24.6	+ 2.1	57	2	33	0	18	16	33	....	....	....	1.18	+ 0.4	8	6,253	nw.	31	nw.	6	5	6	20	7.6	3.6
Northern Slope.							26.8	+ 2.0										78	1.33	+ 0.6										6.4	
Havre	2,505	11	44	27.36	30.12	+ .07	15.8	− 5.3	51	3	26	−15	14	5	40	15	13	87	1.72	+ 1.1	11	6,642	e.	42	sw.	18	1	10	20	7.5	17.2
Miles City	2,371	26	48	27.52	30.19	+ .09	20.6	+ 1.3	52	3	30	−14	15	11	37	16	13	78	1.39	+ 1.1	9	3,698	s.	26	w.	6	10	9	12	5.6	12.0
Helena	4,110	8	56	25.79	30.12	− .01	25.3	0.0	50	7	33	− 3	31	18	42	23	20	81	1.96	+ 1.0	12	3,091	nw.	40	w.	19	1	10	20	8.0	14.6
Kalispell	2,962	8	34	26.93	30.07	.00	27.2	......	44	7	33	6	31	22	25	26	24	89	2.09	......	20	2,340	nw.	26	sw.	5	1	2	28	9.2	15.3
Rapid City	3,234	46	50	26.61	30.16	+ .07	26.4	− 3.8	66	2	38	− 2	9	15	42	23	20	82	0.93	+ 0.7	6	4,111	w.	32	n.	6	15	4	12	5.0	10.1
Cheyenne	6,088	56	64	23.99	30.08	− .01	35.6	+ 7.1	60	23	46	13	17	26	33	29	21	59	0.15	− 0.1	2	7,960	nw.	42	nw.	20	12	8	11	5.3	0.7
Lander	5,372	26	36	24.63	30.13	− .02	29.2	+ 8.4	56	11	40	4	1	18	36	24	19	71	0.92	+ 0.1	2	2,082	sw.	28	sw.	11	14	16	1	3.8	8.2
Yellowstone Park	6,200	11	48	23.84	30.10	− .06	28.5	......	48	3	35	1	31	22	31	25	21	76	1.84	......	15	6,065	s.	38	s.	7	4	9	18	7.5	19.5
North Platte	2,821	11	51	27.14	30.17	+ .07	33.2	+ 6.1	65	3	46	10	18	21	38	27	23	80	0.96	+ 0.4	5	5,499	w.	30	nw.	21	10	10	11	5.3	4.0
Middle Slope.							38.8	+ 3.9										70	0.37	− 0.5										4.7	
Denver	5,291	129	136	24.73	30.08	.00	39.8	+ 7.8	70	11	52	10	17	27	40	32	24	33	0.01	− 0.6	1	5,607	s.	36	w.	19	14	14	3	3.7	T.
Pueblo	4,685	80	86	25.31	30.08	.00	39.2	+ 5.5	73	7	54	7	16	24	45	30	21	55	T.	− 0.5	0	4,967	nw.	41	nw.	26	19	10	2	3.1	T.
Concordia	1,398	42	47	28.65	30.17	+ .06	34.2	+ 1.2	63	4	43	7	18	25	34	30	27	80	0.76	+ 0.2	3	4,957	s.	20	s.	12	9	11	11	5.5	
Dodge	2,509	44	54	27.47	30.14	+ .04	38.2	+ 5.6	70	12	49	11	18	27	40	32	27	77	0.30	+ 0.3	4	7,015	nw.	34	w.	5	10	10	11	5.5	0.1
Wichita	1,358	78	86	28.70	30.18	+ .07	38.2	+ 0.3	69	4	47	12	18	30	30	34	30	71	0.35	− 0.6	4	6,893	s.	32	w.	5	9	11	11	5.9	T
Oklahoma	1,214	10	47	28.85	30.16	+ .05	43.2	+ 3.1	74	3	52	13	18	34	31	39	35	79	0.79	− 1.3	6	12,140	s.	47	s.	24	9	4	18	4.5	2.3
Southern Slope.							49.6	+ 6.1										75	0.59	− 0.3										4.6	
Abilene	1,738	45	54	28.33	30.16	+ .05	50.6	+ 3.1	78	4	61	25	18	40	35	45	41	77	0.49	− 1.0	5	6,203	s.	28	s.	8	7	13	11	5.8	2.8
Amarillo	3,676	10	49	26.32	30.10	+ .01	45.8	+ 9.5	74	8	58	25	16	34	37	38	33	74	0.19	− 0.8	1	4,097	s.	31	s.	7	19	8	4	3.4	T.
Del Rio	944	8	57	29.15	30.15	+ .05	56.8	......	83	10	68	28	20	46	42	....	....	....	0.70	......	6	5,267	se.	28	nw.	30	11	12	8	5.2	T.
Roswell	3,578	9	57	26.40	30.10	+ .03	45.0	+ 5.6	71	13	58	25	19	32	43	38	34	76	0.99	+ 0.4	7	4,044	s.	34	nw.	27	8	11	12	5.9	0.1
Southern Plateau.							45.0	+ 2.4										67	1.93	+ 1.0										4.3	
El Paso	3,762	10	110	26.29	30.11	+ .08	49.2	+ 3.1	77	12	60	27	19	38	34	41	35	65	1.20	+ 0.7	7	6,499	nw.	44	w.	29	16	8	7	4.2	0.3
Santa Fe	7,013	33	39	23.30	30.17	+ .11	35.0	+ 4.2	56	11	45	11	17	25	29	29	23	68	1.78	+ 0.9	7	5,488	ne.	34	nw.	5	19	7	5	3.5	0.5
Flagstaff	6,907	12	44	23.37	30.08	+ .02	32.9	+ 2.2	57	24	44	8	30	22	38	28	25	81	4.77	+ 2.8	10	4,072	w.	31	sw.	12	11	9	11	5.3	11.1
Phoenix	1,108	50	56	28.90	30.07	+ .03	54.3	+ 2.0	78	22	65	33	17	43	38	47	41	65	2.59	+ 1.7	9	2,273	e.	30	sw.	31	11	13	7	4.6	
Yuma	141	16	46	29.93	30.08	+ .03	56.6	+ 0.7	80	23	68	36	16	45	32	47	39	58	0.36	− 0.1	3	4,721	n.	31	w.	31	20	7	4	2.7	
Independence	3,910	11	42	26.06	30.10	− .02	41.8	+ 2.5	62	20	52	24	14	32	31	36	29	67	0.88	− 1.1	9	5,434	nw.	36	n.	31	12	5	14	5.4	1.0
Middle Plateau.							34.8	+ 5.1										77	1.79	+ 0.8										6.1	
Reno	4,532	56	63	25.49	30.12	− .03	36.1	+ 2.7	62	7	45	11	2	27	31	32	30	82	2.43	+ 1.4	13	3,103	sw.	40	s.	10	8	10	13	6.1	13.2
Tonopah	6,089	12	20	24.08	30.20	......	33.6	......	51	21	38	12	1	29	16	30	26	75	1.83	......	9	7,688	se.	42	se.	10	9	11	11	5.5	12.0
Winnemucca	4,344	18	56	25.65	30.13	− .05	34.0	+ 2.9	55	26	42	− 2	2	26	37	31	28	84	1.25	0.0	10	4,817	ne.	34	sw.	10	6	8	17	7.0	11.7
Modena	5,479	10	43	24.66	30.13	+ .01	31.3	+ 2.9	55	23	41	6	15	22	34	28	26	83	2.13	+ 1.8	8	5,382	w.	36	w.	12	6	10	15	6.5	3.1
Salt Lake City	4,366	105	110	25.68	30.12	− .03	38.4	+ 5.6	61	11	45	17	15	32	25	34	28	67	1.06	− 0.6	9	3,556	se.	30	sw.	12	5	9	17	7.0	4.5
Durango	6,546	18	56	23.71	30.16	+ .09	34.0	+ 7.8	57	22	45	10	30	23	35	28	25	76	3.06	+ 1.7	10	3,636	nw.	29	w.	4	11	12	8	5.1	6.7
Grand Junction	4,608	43	51	25.49	30.14	+ .04	36.4	+ 8.6	61	12	46	17	18	27	29	31	27	74	0.74	+ 0.3	6	2,640	nw.	33	sw.	12	11	9	11	5.4	0.5
Northern Plateau.							35.9	+ 5.6										82	2.54	+ 0.7										8.4	
Baker City	3,471	48	58	26.45	30.11	− .05	33.4	+ 4.9	50	7	39	11	1	27	22	31	28	82	1.76	0.0	16	3,821	se.	24	s.	3	1	7	23	8.3	10.1
Boise	2,739	78	86	27.24	30.15	− .05	38.7	+ 5.5	59	10	45	13	2	32	26	35	30	74	1.99	0.0	15	4,465	se.	33	se.	10	5	2	24	8.3	3.0
Lewiston	757	10	51	29.26	30.09	− .04	38.4	+ 1.2	52	21	42	26	1	35	15	....	....	....	2.68	+ 1.4	16	3,378	e.	44	nw.	7	1	3	27	9.2	3.7
Pocatello	4,477	46	54	25.53	30.14	− .05	35.2	+ 9.2	54	25	42	0	1	28	32	31	27	73	1.47	− 0.1	13	7,260	se.	44	sw.	12	7	12	12	6.1	3.0
Spokane	1,929	101	110	27.98	30.08	.00	32.4	+ 1.1	50	7	36	18	4	28	19	31	30	90	3.71	+ 1.2	23	3,083	ne.	28	sw.	7	0	4	27	9.3	18.4
Walla Walla	1,000	71	79	29.00	30.09	− .03	37.3	− 0.4	63	7	43	24	4	32	32	35	34	93	3.63	+ 1.5	20	3,229	s.	40	se.	10	0	2	29	8.9	4.7
N. Pac. Coast Reg.							42.6	+ 0.7										87	7.03	− 1.4										8.2	
North Head	211	11	56	29.75	29.98	− .05	44.4	+ 0.6	58	21	48	33	31	41	14	43	41	89	7.87	− 2.1	25	10,973	se.	94	se.	10	4	7	20	7.5	
Port Crescent	259	12	29	29.66	29.94	− .04	39.4	0.0	57	7	44	28	27	35	20	....	....	....	5.95	− 1.0	23	4,164	se.	36	sw.	6	1	5	25	8.4	0.5
Seattle	128	185	224	29.89	30.02	+ .01	42.4	− 0.2	56	21	47	30	27	38	18	41	38	85	6.80	+ 0.7	20	6,156	se.	63	s.	10	1	9	21	8.3	0.7
Tacoma	213	118	120	29.79	30.03	+ .02	41.8	+ 0.9	58	21	47	27	14	37	19	....	....	....	6.72	− 0.7	22	4,234	sw.	46	sw.	10	1	9	21	8.1	7.0
Tatoosh Island	86	7	57	29.84	29.94	− .02	43.1	− 0.2	54	22	46	31	31	40	17	41	39	85	10.43	− 4.0	26	14,383	e.	86	sw.	7	2	3	26	8.5	1.5
Portland, Oreg.	153	68	106	29.86	30.03	− .04	43.1	+ 1.8	60	6	47	29	4	39	21	41	39	85	7.55	− 0.2	22	4,420	se.	38	s.	10	2	4	25	8.5	
Roseburg	510	9	57	29.49	30.05	− .06	43.7	+ 1.7	64	6	49	29	3	38	22	42	41	91	3.88	− 2.6	22	1,542	s.	24	sw.	10	0	10	21	8.1	0.3

TABLE I.—*Climatological data for U. S. Weather Bureau stations, December, 1906*—Continued.

Stations.	Elevation of instruments. Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Temperature of the air, in degrees Fahrenheit. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches. Total.	Departure from normal.	Days with .01, or more.	Wind. Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
Mid. Pac. Coast Reg.							48.3	− 0.3										84	6.59	+ 1.8										7.6	
Eureka	62	62	80	30.00	30.07	− .05	49.4	+ 0.8	63	6	54	36	1	44	21	47	45	85	7.59	+ 0.3	19	3,939	se.	45	sw.	10	3	6	22	7.8	
Mount Tamalpais	2,375	11	18	27.59	30.09	− .03	44.6	......	65	21	49	30	31	40	25	41	38	82	5.28	......	14	14,079	nw.	69	se.	10	6	5	20	7.1	
Point Reyes Light	490	7	18	29.52	30.04	......	50.4	+ 0.5	62	22	54	39	31	46	20	...	...	...	6.40	+ 1.0	13	13,629	s.	92	s.	10	7	8	16	6.7	
Red Bluff	332	50	56	29.73	30.10	− .04	46.3	− 0.4	65	2	53	30	21	40	29	43	40	84	8.13	+ 2.8	15	3,874	nw.	34	se.	10	6	3	22	7.4	
Sacramento	69	106	117	30.04	30.11	− .03	46.7	− 0.4	61	10	52	30	2	41	30	44	42	84	7.37	+ 3.2	13	5,482	se.	52	se.	10	7	5	19	7.0	
San Francisco	155	200	204	29.94	30.11	− .01	49.6	− 1.8	61	10	54	40	2	45	21	46	44	85	6.90	+ 1.9	15	4,951	nw.	53	sw.	10	7	11	13	6.2	
San Jose	141	78	88	29.94	30.10	......	48.4	......	64	10	56	26	2	40	35	...	...	...	6.39	......	13	......	nw.	...	......	...	10	6	15	6.0	
Southeast Farallon	30	9	17	30.05	30.08	......	51.1	......	57	27	54	45	31	49	10	...	...	...	4.65	......	13	10,634	nw.	76	s.	10	9	6	16	5.7	
S. Pac. Coast Reg.							53.5	+ 0.8										76	4.36	+ 1.3										5.8	
Fresno	330	67	70	29.78	30.14	+ .01	47.4	+ 1.1	66	26	54	27	2	41	26	45	42	84	3.16	+ 1.7	13	2,849	se.	19	nw.	31	6	5	20	7.7	
Los Angeles	338	116	123	29.72	30.09	+ .02	56.4	+ 1.0	84	21	65	39	17	48	30	50	44	69	5.12	+ 1.1	10	3,289	ne.	24	nw.	31	12	5	14	5.6	
San Diego	87	94	102	29.98	30.07	.00	56.4	+ 0.6	80	21	64	41	16	49	24	50	45	71	4.02	+ 1.9	12	4,473	e.	38	w.	31	18	5	8	4.1	
San Luis Obispo	201	47	54	29.89	30.11	.00	53.8	+ 0.4	81	21	63	36	30	45	34	49	45	78	5.14	+ 0.6	13	4,414	n.	27	se.	11	10	7	14	5.7	
West Indies.																															
Grand Turk	11	6	20	30.06	30.07	+ .06	74.4	......	84	22	80	60	26	69	...	...	...	...	2.58	......	18	......	ne.	...	......	...	...	...	...	...	
San Juan	82	48	90	29.91	30.00	+ .03	74.8	− 2.9	82	11	79	67	31	70	12	69	66	76	8.45	+ 4.2	24	10,761	ne.	36	ne.	17	2	20	9	6.5	
Panama.																															
Ancon	74	...	...	......	......	......	......	......	...	...	...	...	...	...	...	...	...	...	......	......	...	......	......	...	......	...	...	...	...	...	...
Naos	40	...	...	......	......	......	......	......	...	...	...	...	...	...	...	...	...	...	......	......	...	......	......	...	......	...	...	...	...	...	...

TABLE II.—*Climatological record of cooperative observers, December, 1906.*

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Alabama.	°	°	°	*Ins.*	*Ins.*
Alaga				4.58	
Ashville	70	12	47.5	5.42	
Auburn	73	19	51.0	4.20	
Benton				5.58	
Boligee	80	20	53.4	4.44	
Bridgeport				3.74	T.
Burkeville				3.71	
Calera				3.23	
Camphill				4.07	
Cedar Bluff				5.17	
Citronelle	83	22	57.2	2.41	
Clanton	74	17	50.8	5.23	
Cordova				5.78	
Dadeville				4.20	
Daphne	80	25	58.5	4.10	
Decatur	70[e]	24[e]	47.1[e]	3.59	
Demopolis				4.46	
Eufaula	76	20	49.6	5.08	
Evergreen	81	23	54.4	2.36	
Flomaton	80	20	54.2	4.55	
Florence	74	16	47.4	4.05	T.
Fort Deposit				2.45	
Gadsden	77	17	49.8	4.55	
Goodwater	77	22	49.6	3.10	
Greensboro	73	21	51.8	4.30	
Greenville				2.90	
Guntersville				3.98	T.
Hamilton	75	15	48.8	4.33	
Highland Home	74	19	52.8	4.08	
Lotohatchie				2.60	
Livingston	74	20	49.7	2.82	
Lock No. 4	71	18	48.2	6.46	
Lucy	79[d]	22[d]	54.2[d]	3.98	
Madison Station	76	15	48.7	3.91	
Maplegrove	73	17	46.6	5.72	T.
Milstead				4.90	
Newbern	75	18	52.6	3.46	
Oneonta	70	12	47.0	5.03	T.
Opelika	74[f]	17	49.5[e]	3.99	T.
Prattville	77	21	50.4	4.15	
Pushmataha	81	20	53.8	4.18	
Riverton	74	15	44.8	5.94	0.1
Scottsboro	71	14	47.0	3.54	
Selma	76	20	52.0		
Spring Hill				3.05	
Talladega	73	17	49.8	5.71	
Tallassee				4.37	
Thomasville	75	20	51.0	2.58	
Tuscaloosa	75	19	50.4	5.67	
Tuscumbia	71	19	47.3	3.83	
Tuskegee	78	19	52.8	3.94	T.
Union Springs	77	18	51.2	2.75	
Uniontown	76	19	52.8	2.84	
Valleyhead	72	10	44.6	4.08	T.
Vienna				4.14	
Wetumpka	77	19	52.0	3.06	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Alaska.	°	°	°	*Ins.*	*Ins.*
Killisnoo	43	6	26.9	2.50	10.0
Loring	44	8	27.0	8.41	7.5
Sitka	45	9	32.0	6.61	1.0
Skagway	39	− 4	18.0	0.33	3.0
Arizona.					
Allaire Ranch				3.08	0.5
Aztec	80	30	52.0	1.02	
Benson	79	21	49.3	1.73	
Bisbee	68	28	47.2	5.10	0.4
Bonita				3.62	
Bowie	71	24	48.4	2.40	
Buckeye	75	26	51.8	1.58	
Casagrande	87	17	51.9	3.10	
Chlarsons Mill	54	11	32.6	7.52	21.0
Clifton				5.95	
Cline	79	27	50.8	5.97	
Cochise*[1]	61	28	44.2	2.77	
Columbia	76	28	51.4	7.15	
Congress	73	38	52.1	3.86	
Douglas	73	25	49.6	2.36	
Dudleyville	79	26	51.4	4.49	
Duncan	70	24	47.6	3.33	1.0
Flagstaff	59	2	33.9	4.81	19.5
Fort Apache	70	18	42.9	4.72	3.0
Fort Huachuca	69	28	47.0	3.75	
Fredonia	58	16	38.6	1.50	3.0
Gilabend	69	32	52.6	2.43	
Grand Canyon	65	20	42.0	7.51	11.0
Greaterville	70	18	43.8	4.85	
Greer				4.99	21.0
Holbrook	62	15	39.2	2.32	
Huachuca Reservoir				8.40	
Jerome	67	29	44.8	4.20	
Keams Canyon	58	11	36.4		
Kingman	73	21	46.8	1.87	
Maricopa	81	30	52.2	2.67	
Mesa	83	34	53.7	3.52	
Mohawk Summit*[1]	78	40	56.6	0.94	
Natural Bridge				7.08	6.0
Nutrioso				4.75	9.0
Oracle	69	29	48.4	7.80	
Paradise	78	21	46.0	5.37	
Parker	80	25	53.4	1.86	
Phoenix (Ex. Farm)	78	30	54.4	2.54	
Picacho*[5]	76	40	57.2	3.34	
Pinal Ranch				9.69	5.0
Pinto				1.70	
Prescott	64	10	39.2	3.61	10.6
Roosevelt	82	24	52.7	4.08	T.
St. Michaels	54	11	33.4	1.93	5.6
San Carlos	75	25	49.4	3.92	2.0
San Simon	75	22	49.5	1.91	1.0
Seligman	65	18	39.8	2.81	2.0
Sentinel	80[k]	32[k]	54.6[k]	0.77	
Signal	70	30	51.4	1.83	
Silverbell	78	39	56.9	3.48	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Arizona—Cont'd.	°	°	°	*Ins.*	*Ins.*
Tempe	79	30	52.8	2.75	
Thatcher	70	23	47.6	1.79	2.5
Tombstone	67	26	47.0	2.72	4.0
Tuba	58	16	39.2	2.23	8.5
Tucson	78	29	53.5	4.57	
Upper San Pedro	75	24	47.5	2.50	
Vail*[5]	60	33	44.7	1.50	
Walnut Grove				4.20	1.0
Willcox	68	24	46.4	4.07	
Yarnell				5.22	1.0
Young	71	8	41.0	7.80	5.0
Arkansas.					
Alicia	70	21	44.1	6.51	
Amity	80	23	49.4	4.90	
Arkadelphia	80	23	49.3	4.80	
Arkansas City				6.64	
Batesville	76	18	44.8	5.42	
Beebranch	70	22[i]	46.2[e]	2.95	
Black Rock				6.42	
Brinkley	78	21	46.5	6.91	T.
Calico Rock				5.65	
Camden				5.47	
Center Point	80	25	50.6	5.67	T.
Clarendon				7.54	T.
Conway	75	24	47.0	5.03	T.
Cornerstone	78[f]	26[f]			
Corning	70	18	43.2	7.15	T.
Dardanelle				4.76	
Des Arc[g]	83	25	49.1		
Dodd City	67	16	42.4	3.90	0.5
Dutton[f]	73	18	42.6		
Earl	80	21	46.9	6.11	
Eldorado	80	26	49.5	6.85	1.0
Eureka Springs	71	16	43.8	2.02	1.0
Fayetteville	70	18	44.0	2.20	T.
Forrest City	71	19	46.2	6.09	
Fulton				4.20	
Hardy	70	18	42.7	6.50	T.
Harrison	70	12	40.4	3.84	T.
Heber	78	19	46.6	3.69	
Helena	72	25	49.4	8.23	T.
Hope	80	25	51.7	5.70	T.
Hot Springs	73	21	47.4	5.52	
Huntsville	68[e]	15[e]	43.0[e]	3.11	0.5
Jonesboro	79	18	47.1	7.30	0.5
La Crosse	71	20	42.4	3.92	
Lewisville	81	24	50.1	4.96	
Lutherville	78	20	45.0	7.69	T.
Luxora				3.80	T.
Malvern	78	22	45.6	5.05	T.
Mammoth Springs	70	16	41.6	4.88	1.0
Marked Tree				2.55	T.
Marvell	75	21	47.8	6.26	
Mena	78	24	48.4	7.81	
Montrose	80	23	51.0	6.46	
Mount Nebo	66	20	43.2	7.40	T.

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Arkansas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Newport	77	27	47.2	4.28	
Ozark	76[d]	22[d]	46.0[d]	4.74	
Pinebluff	77	23	48.2	9.11	1.0
Pocahontas	74	17	44.6	6.99	
Pond	73	10	43.0	1.15	0.5
Prescott	80	25	50.1	5.04	
Princeton	78	22	49.2	8.34	2.0
Rogers	70	17	44.0	1.23	1.1
Russellville	73	23	44.6	4.21	
Spielerville	75	24	47.0	5.50	
Stuttgart	82	21	47.4	7.02	T.
Texarkana	82	29	53.7	6.20	T.
Warren	80	19	48.2	6.90	
White Cliffs				5.01	T.
Wiggs	79	19	47.4	6.53	
Winchester	79	23	49.2	8.09	
Witts Springs				7.18	
California.					
Alturas	56	4	33.6	3.52	10.0
Angiola	71[e]	26[e]	47.2[e]	1.95	
Auburn	69	32	51.7	15.39	
Azusa	84	33	52.8	6.81	
Bagdad	70	31	53.2	0.80	
Bakersfield	72	27	48.8	1.00	1.5
Barstow	71	24	45.6	T.	
Bear Valley				20.56	63.0
Berkeley	58	37	48.7	7.24	
Bishop	64	15	39.0	2.15	0.5
Blocksburg	63	31	44.8	12.88	
Blue Canyon	65	20	40.1	16.40	53.0
Bodie	50	−9	22.4	2.60	36.0
Bowman				15.46	92.0
Branscomb	65	25	44.6	16.51	T.
Brush Creek	56	24	36.4	22.92	1.0
Butte Valley				12.33	42.0
Calexico	73	34	53.6	1.31	
Campbell	63	28	47.4	6.42	
Campo				7.15	4.0
Cedarville	55	8	33.8	1.94	15.0
Chico	68	24	46.2	8.66	
Claremont	85	32	54.0	6.89	
Cloverdale	65	27	48.9	11.45	
Colfax	74	19	45.4	17.51	4.0
Colusa	65	30	46.6	3.92	
Crescent City	59	29	42.8	11.86	
Crockers				11.51	25.5
Cuyamaca	57	15	36.4	9.13	9.0
Delta	71	28	52.4	17.14	
Diamond				7.39	
Dobbins	67	34	50.6	14.91	
Durham	68	27	47.4	8.84	
Elcajon	86	32	55.0	4.14	
Electra	64	29	49.9	13.97	
Elmwood	71	31	49.4	2.60	
Elsinore	80	28	49.4	5.09	
Emigrant Gap	56	10	35.3	16.55	80.0
Escondido	79	25	50.9	5.51	
Folsom	64	26	47.7	12.66	
Fordyce				16.98	128.0
Fort Bragg				9.82	
Fort Ross	66	38	53.2	13.02	
Fouts Springs				19.86	1.0
Georgetown	71	29	45.0	19.82	6.0
Gilroy (near)	69	30	49.9	8.23	
Gold Run	75	25	50.8	13.90	7.0
Grass Valley				18.32	3.0
Greenville	57	15	36.0	16.14	31.5
Groveland				9.95	4.0
Hanford	79	26	52.8	3.43	
Healdsburg	70	28	49.4	11.23	
Heber	82	27	55.2	1.23	
Hollister	65	25	48.1	7.12	
Indio	81	32	55.2	1.89	
Idylwild	73	18	41.6	5.25	7.0
Imperial	81	27	53.4	1.46	
Iowa Hill	73	29	45.8	17.36	5.2
Isabella				2.80	0.8
Jamestown	66	22	45.3	12.72	1.5
Kennedy Gold Mine				13.60	1.0
Kentfield				11.06	
Kernville				2.36	1.0
King City	75	20	48.6	4.05	
Laporte	61	6	37.9	21.79	78.6
Laytonville				13.31	
Legrande	68	23	44.1	4.06	
Lemoncove	78	29	51.0	6.14	
Lick Observatory	64	22	42.2	10.31	4.0
Livermore	73[e]	26[e]	48.1[e]	6.45	
Lodi	58	23	47.2	9.47	
Lone Pine	63	21	41.3	0.62	T.
Los Gatos	65	35	47.8	11.39	
Lowe Observatory				11.85	
Magalia	61	14	39.4	24.84	3.0
Mammoth	88	30	66.2	0.30	
Marysville	68[g]	27	49.4	9.93	
Mena	76[i]	33[i]	53.4[i]	1.72	
Merced	68	21	46.2	3.90	
Mercury				10.27	

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
California—Cont'd.	°	°	°	*Ins.*	*Ins.*
Mills College				6.51	
Milo				7.67	7.0
Milton (near)	62	33	47.6	9.18	
Mohave	68	31	47.4	2.25	
Mokelumne Hill	60	31	45.8	13.60	2.0
Mono Ranch	64	27	44.2	12.49	3.5
Montague	59	18	38.0	2.74	2.0
Monterio	66	22	45.7	2.75	
Monumental	56	20	38.4	16.79	31.0
Mountainview				5.36	
Mount St. Helena				12.93	
Napa	61	32	49.0	6.07	
Needles	76	31	51.8	0.80	
Nevada City	75	22	43.4	17.74	2.0
Newman	64[d]	28[d]	46.7[d]	5.91	
Niles	62	30	49.0	6.80	
Nimshew	60	32	43.6	23.26	6.0
North Bloomfield	70	21	42.2	16.08	8.0
Oakland	60	36	49.2	5.68	
Ojai Valley	90	30	54.4	8.40	
Orleans	68	27	47.9	10.55	
Oroville (near)	66	32	48.3	10.70	
Palermo	68	29	47.4	8.83	
Peachland	68	26	47.4	8.88	
Pine Crest	79	40	54.9	11.19	
Placerville	59	24	43.4	15.02	5.0
Point Lobos	61	43	54.6	5.77	
Porterville	71	30	48.1	3.80	
Poway	79	28	53.2	6.34	
Priest Valley				6.79	
Quincy	46	15	33.2	13.89	23.2
Redding	65	30	45.8	10.66	
Redlands	81	30	51.8	5.21	
Reedley	68	23	47.7	4.24	
Represa				13.53	
Rialto	77	32	54.0	12.71	1.5
Riovista	62	28	46.4	6.51	
Riverside	85	28	52.4	4.43	
Rocklin	62	23	48.6	10.86	
Sacramento	62	24	46.8	9.45	
Salinas	68[h]	28[h]	50.6[h]	7.92	
Salton [a,b]	71	56	60.5	3.75	
San Bernardino	84	27	53.0	7.12	
San Jacinto	86	29	52.6	4.79	
San Leandro	68	30	50.3	7.92	
San Miguel Island				2.29	
Santa Barbara	80	35	55.1	6.46	
Santa Clara College	65	25	48.6	6.50	
Santa Cruz	76	29	51.5	8.53	
Santa Maria	70	34	52.8	4.35	
Santa Monica	79	40	54.2	6.29	
Santa Rosa	66	25	47.3	6.79	
Shasta	69	30	45.7		
Sierra Madre	76	38	53.7	11.06	
Sisson	52	25	37.2	8.64	1.0
Sonoma	67	27	48.0	8.44	
Sonora	69	24	45.6	12.57	3.0
Sterling	66	20	41.6	25.92	14.2
Stockton	63	26	46.0	8.05	
Storey	66	20	45.3	3.61	
Summerdale	60	21	39.0	15.24	44.0
Summit	58	4	30.6		
Susanville	54	11	33.2	5.86	34.0
Tamarack	56	2	32.0	19.80	19.8
Towle	80	25	44.2	16.86	23.0
Truckee	66	−12	32.4	5.10	51.0
Tulare	72	22	47.2	3.29	
Tustin (near)				3.34	1.0
Ukiah	64	24	47.2	10.14	
Upland	72	34	50.2	9.10	
Upperlake	65	26	45.8	6.81	
Upper Mattole				15.87	
Vacaville	70	24	47.6	7.06	
Visalia	86	24	50.8	3.22	0.4
Wasioja				5.16	2.0
Westpoint				14.29	6.0
West Saticoy				5.67	
Wheatland	63	24	46.0	10.32	
Willows	66	28	46.5	5.35	
Woodleaf				25.76	4.0
Woodside	60	32	47.5	6.72	
Yosemite	55	20	34.4	11.02	35.5
Yreka				3.92	
Zenia	70	22	43.2	15.19	T.
Colorado.					
Akron				0.08	
Antelope Springs	45	−32	10.9	2.01	12.1
Arriba	70	0	35.	0.05	0.5
Ashcroft	58	−10	23.5	1.17	13.5
Blaine	75	12	40.8	0.00	
Boulder	68	13	41.3	T.	0.0
Breckenridge	56	−15	24.6	0.84	11.0
Buena Vista	54	1	30.6	0.23	T.
Burlington	72	6	37.4	0.04	0.3
Canyon	75	12	44.4	0.00	
Cascade				2.45	20.2
Castlerock	69	0	33.0	0.00	
Cheesman	65	6	37.4	0.02	T.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Colorado—Cont'd.	°	°	°	*Ins.*	*Ins.*
Cheyenne Wells	70	6	38.0	T.	T.
Chromo	59	3	30.7	2.00	16.5
Clearview	59	2	31.0	0.48	6.5
Collbran	55	4	31.4	0.83	6.0
Colorado Springs	68	5	37.4	0.10	1.0
Cope	73	3	37.2	0.58	3.0
Corona	39	−10	16.8	3.14	19.5
Cripplecreek				T.	0.3
Dunkley	56	−14	25.6	1.24	11.4
Eagle	57	−2	28.2	0.65	4.0
Agricultural College	64	7	34.8	0.12	
Fort Morgan	68	3	35.0	T.	T.
Fowler				0.03	T.
Frances	55	5	30.8	0.45	6.5
Fruita	62	12	35.0	1.02	0.5
Garnett	50	−1	27.0	0.54	4.5
Gladstone				3.02	39.0
Gleneyre	70	1	38.0	0.00	
Glenwood	60	0	28.1	1.14	12.0
Gothic	49	−15	20.2	3.40	41.5
Grand Valley	55	9	34.0	1.37	5.0
Greeley	65	6	36.0	0.03	
Grover				0.00	
Gunnison	57	−9	23.8	0.64	4.7
Hahns Peak	60	−18	26.7	2.32	30.0
Hamps	70	0	34.8	0.05	1.0
Hoehne	70	−1	36.9	9.66	3.0
Holly	75	7	39.3	0.00	
Idaho Springs	61	5	34.5	0.00	
Lake City	50	−6	25.2	0.68	5.0
Lake Moraine	51	−4	27.8	0.02	0.5
Lamar	76	6	39.4	0.15	T.
Laporte				0.00	
Las Animas	74	5	37.8	0.00	
Lay	55	−21	24.1	0.63	9.0
Leroy	64	7	35.6	0.53	3.5
Longs Peak	59	−7	28.6	0.20	2.0
Lujane	59	9	33.6	0.69	4.0
Mancos	61	3	34.0	2.04	8.3
Manassas	51	−2	27.8	0.90	5.5
Meeker	55	−3	28.8	0.92	5.0
Montrose	61	6	32.4	0.32	3.0
Moraine	62	3	32.8	T.	T.
Pagoda	60	−10	27.3	0.43	6.0
Pagosa Springs	70	2	33.5	3.48	12.2
Pavonia	61	10	35.6	1.35	4.5
Platte Canyon				0.00	
Power House	55	9	34.6	1.58	3.5
Rangely	49	−5	24.3	0.07	1.5
Red Mountain				3.02	34.0
River Portal	55	7	28.4	0.91	5.1
Rockyford	75	5	36.4	T.	
Saguache	50	3	28.8		
Salida	48	3	29.9	0.35	1.0
San Luis	56	−6	30.0	0.09	0.6
Sapinero	48	−8	24.0	1.10	12.5
Sheridan Lake	71	2	37.0	0.17	T.
Silt	59	6	33.2	0.57	6.5
Silverton	54	−22	15.1	1.09	12.5
Stonewall				0.35	4.0
Terminal Dam				2.24	9.5
Trinidad	71	12	41.2	0.30	5.0
Victor	63	7	36.6	0.05	0.3
Vilas				0.46	
Wagon Wheel	51	−30	15.1	1.74	23.0
Waterdale	66	7	37.4	T.	
Westcliff	62	−3	32.3	0.12	3.0
Whitepine	46[f]	−9	22.2[e]	1.10	16.0
Wray	69	6	36.8	0.29	T.
Yuma				0.12	T.
Connecticut.					
Bridgeport	53	5	30.2	4.35	6.9
Canton	49	−2	24.6	4.09	5.5
Colchester	52	−1	27.2	3.58	9.0
Falls Village				2.92	11.0
Hawleyville	55	−1	28.2	2.86	7.5
Lake Konomoc				3.52	
New London	53	3	29.2	4.21	6.5
North Grosvenor Dale	52	−1	25.3	3.34	
Norwalk	52	3	28.5	4.78	5.0
Southington	51	2	27.8	2.60	7.5
Storrs	52	−3	26.4	2.80	
Voluntown	55	−1	28.7	4.23	7.5
Wallingford				3.77	13.0
Waterbury	54	−2	28.2	4.13	6.0
West Cornwall	44	−5	23.4	3.84	13.0
West Simsbury				4.03	6.0
Delaware.					
Delaware City				4.14	T.
Dover	66	12	37.0	3.33	T.
Milford	67	12	39.0	3.87	T.
Millsboro	72	11	39.0	3.52	T.
Newark	62	10	35.2	6.01	T.
Seaford	62	12	37.5	3.45	T.
District of Columbia.					
West Washington	72	9	35.6	4.01	0.3
Florida.					
Apalachicola	77	26	58.4	3.15	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
	°	°	°	*Ins.*	*Ins.*
Florida—Cont'd.					
Archer	84	16	57.4	0.68	
Avon Park	85	24	61.9	0.18	
Bartow	82	20	60.3		
Bonifay	77	23	56.7	5.68	
Brooksville	86	24	61.3	0.37	
Clermont	85	27	63.0	0.18	
De Funiak	79	24	56.2	6.66	
Deland	85	19	60.0		
Eustis	83	24	59.8	0.34	
Federal Point	80	25	58.4	0.44	
Fenholloway	80	18	56.2	1.50	
Fernandina	80	25	57.9	1.42	
Flamingo	86	33	68.6		
Fort Meade	85	14	59.0	T.	
Fort Myers	80	31	62.4	0.02	
Fort Pierce	84	29	64.8	0.21	
Gainesville	81	19	56.4	0.35	
Grasmere	77	27	59.0		
Huntington	80	22	57.2	0.21	
Hypoluxo	81	30	66.2	0.16	
Inverness	85	18	59.2	0.11	
Jasper	79	20	55.7	1.53	
Johnstown	80	17	53.6	1.07	
Kissimmee	81	20	58.9	0.04	
Macclenny	81	17	54.6	1.18	
Madison	89	20	55.6	1.22	
Malabar	84	25	63.2	0.26	
Manatee	83	23	62.1	0.17	
Marianna	80[h]	22[h]	54.9[h]	......	
Merritt Island	81	29	63.0	0.20	
Miami	84	32	67.4	0.00	
Middleburg	79	19	55.1	0.27	
Molino	83	19	55.2	5.28	
Monticello	77	22	54.7	2.23	
Mount Pleasant	......	......	......	2.42	
New Smyrna	85	25	61.0	0.40	
Ocala	84	22	59.6	0.54	
Orange City	87	19	59.0	0.00	
Orange Home	85	22	59.6	0.14	
Orlando	83	25	60.2	0.05	
Plant City	85	19	61.2	0.05	
Rockwell	81[g]	20[g]	60.5[g]	0.23	
St. Andrew	78	26	57.0	1.36	
St. Augustine	81	24	58.7	0.86	
St. Leo	83	25	61.0	0.13	T.
Stephenville	81	15	55.6	1.12	
Switzerland	80	23	56.5	0.90	
Tallahassee	78	23	54.6	2.35	
Tarpon Springs	82	21	60.2	0.25	T.
Wausau	86	22	56.4	9.55	
Georgia.					
Abbeville	......	......	......	2.82	
Albany	79	20	53.0	2.12	
Allapaha	78	19	51.6	1.60	
Athens	69	17	46.9	3.55	
Bainbridge	85	19	51.4	2.94	
Blakely	89	21[e]	53.4[e]	3.88	
Brunswick	81	24	55.0	1.29	
Butler	......	......	......	3.50	
Camak	75	15	48.6	2.51	T.
Canton	......	......	......	4.44	T.
Carlton	......	......	......	3.57	
Carrollton	72	15	45.2	5.35	
Clayton	69	11	45.1	7.70	T.
Columbus	76[k]	21[k]	51.6[k]	4.15	
Cordele	75	19	52.8	3.11	
Covington	......	......	......	5.30	
Cuthbert	78	20	53.0	4.63	
Dahlonega	70	14	44.4	6.16	T.
Diamond	64	12	43.4	6.40	0.3
Dublin	......	......	......	2.64	
Dudley	78	19	52.0	2.89	T.
Eastman	77	18	49.5	2.35	
Eatonton	74	16	50.2	3.64	
Elberton	68	14	46.8	3.83	
Experiment	73	16	48.7	3.20	T.
Fitzgerald	77	13	52.4	2.18	
Fleming	80	18	51.2	2.58	
Fort Gaines	81	21	52.0	4.65	
Gainesville	65	16	43.8	4.17	T.
Gillsville	69	15	46.1	4.14	
Glenville	76	21	50.4	1.98	
Greenbush	68	14	44.6	5.67	T.
Greensboro	75	15	47.6	3.54	
Griffin	73	15	48.2	3.98	
Harrison	75	15	50.0	3.06	
Hawkinsville	78	18	50.0	3.63	
Lisbon	74	......	......	3.01	
Lost Mountain	70	14	46.0	5.51	T.
Louisville	79	18	51.2	2.81	
Marshallville	77	18	51.1	4.31	
Mauzy	80	19	54.0	3.11	
Milledgeville	75	16	48.6	4.03	
Millen	77	16	49.2	2.00	
Montezuma	......	......	......	4.42	
Monticello	74	18	48.9	3.88	
Morgan	77	22	52.2	3.88	
Newnan	73	16	47.3	4.36	
Georgia—Cont'd.					
Oakdale	......	......	......	5.03	
Point Peter	70	15	46.2	4.00	
Poulan	79	18	52.4	2.06	
Putnam	76	18	51.4	4.20	
Quitman	78	20	52.6	1.93	
Ramsey	68	16	48.2	5.20	T.
Resaca	......	......	......	3.72	
Rome	72	16	45.8	4.65	T.
St. George	80	22	54.8	0.89	
St. Marys	80	21	54.4	1.00	
Screven	80[c]	19[c]	56.9[c]	1.35	
Statesboro	80[c]	20[c]	48.4[c]	2.19	
Talbotton	75	18	50.6	4.19	
Toccoa	69	13	44.2	6.75	
Valdosta	80	19	53.3	1.04	
Valona	79	20	51.9	1.16	
Washington	67	11	45.3	1.95	
Waycross	79	21	51.7	0.34	
Waynesboro	80	18	51.6	1.48	T.
Westpoint	78	17	47.9	3.64	
Woodbury	71	17	47.2	3.09	
Idaho.					
American Falls	54	1	33.0	0.95	......
Bannock River Cabin	55	-1	33.8	1.29	2.1
Blackfoot	51	-2	32.6	1.25	6.0
Buhl	56	-2	35.2	1.04	5.0
Caldwell	56	6	37.2	1.72	2.0
Cambridge	53	8	33.2	4.36	15.1
Chesterfield	52	-11	29.8	2.25	10.0
Dent	44	22	34.9	7.27	15.3
Dewey	51[c]	1[c]	32.0[c]	2.25	17.9
Ellerslie	53	10	35.6	2.23	10.0
Emmett	59	8	38.8	1.96	4.0
Forney	48	-8	27.2	2.51	20.0
Garnett	58	8	38.0	1.30	......
Hot Springs	61	-3	38.2	1.45	3.5
Idaho Falls	51	-3	31.0	1.01	6.5
Kellogg	43	12	32.4	5.44	18.2
Lake	42	-4[g]	24.4[d]	4.30	43.0
Lakeview	47	20	32.2	5.05	22.0
Landore	45	7	29.6	8.49	50.2
Lardo	46	-2	28.6	6.09	46.5
Lost River	47	-7	25.0	1.68	16.2
Lovell	48	11	31.7	5.25	13.0
Meadows	43	4	30.9	2.82	27.5
Milner	58	-3	33.2	1.99	9.0
Moscow	46	17	33.8	6.12	14.1
Mountain Home	52	-6	34.0	1.49	2.0
Murray	38	10	28.6	5.92	29.0
Murtaugh	55	-9	31.7	0.89	6.5
Nevens Ranch	......	......	......	5.20	5.2
Oakley	52	4	34.3	1.53	9.5
Orofino	44	20	35.5	6.78	16.5
Paris	48	-6	26.0	1.60	3.0
Payette	54	4	36.0	1.60	5.9
Poplars	......	......	......	1.92	2.0
Porthill	48	14	29.7	2.77	28.0
Roosevelt	40	3	24.8	3.49	37.5
Rupert	54	-10	32.6	1.23	5.4
St. Maries	45	15	33.2	5.57	14.5
Salem	......	......	......	1.69	6.9
Salmon	51	-3	27.0	0.85	9.5
Standrod	......	......	......	1.48	10.9
Twin Falls	57	-8	33.3	1.71	4.0
Vernon	49	-1	28.2	2.87	6.0
Weston	54	3	33.4	2.11	3.5
Illinois.					
Albion	67	10	37.0	4.45	3.3
Aledo	56	2	29.6	1.67	0.7
Alexander	58	5	33.2	2.84	0.7
Antioch	48	3	28.6	1.15	T.
Ashton	52	1	27.8	2.00	1.2
Astoria	58	5	31.4	1.76	0.5
Aurora	52	5	29.2	2.48	0.5
Benton	68[e]	14[e]	38.2[e]	3.90	3.0
Bloomington	58	6	31.8	3.68	0.5
Bushnell	58	3	30.6	2.30	......
Cambridge	54	3	29.2	1.88	0.5
Carlinville	60	7	34.6	2.57	1.0
Carlyle	......	......	......	2.13	1.2
Carrollton	65	6	33.3	4.60	0.5
Charleston	60	5	34.6	3.68	1.3
Chester	66	16	39.3	3.22	0.6
Cisne	67	10	38.0	4.14	2.0
Coatsburg	63	1	31.0	1.54	T.
Cobden	66	10	38.5	5.50	1.0
Colchester	59	2	31.2	1.71	0.2
Decatur	60	5	31.4	3.51	0.5
Dixon	51	2	27.2	1.52	......
Dwight	57	4	30.7	2.64	0.9
Elgin	50	5	29.4	1.37	T.
Equality	71	12	39.7	7.52	7.0
Flora	64	9	36.6	3.33	2.3
Friendgrove	65	9	37.5	5.13	3.0
Galva	55	1	27.7	1.78	0.7
Grafton	......	......	......	3.40	0.5
Greenville	65	9	35.2	2.61	1.0
Griggsville	65	7	34.2	2.65	T.
Illinois—Cont'd.					
Halfway	68	12	38.5	6.60	2.0
Havana	61	8	33.2	1.53	T.
Henry	57	2	31.2	2.17	1.0
Hillsboro	62	9	35.7	2.02	1.0
Hoopeston	56	11	32.4	3.57	1.6
Joliet	54	9	30.8	3.13	0.8
Kishwaukee	50	2	27.5	1.74	0.1
Knoxville	56	2	30.0	1.81	0.5
Lagrange	53	8	29.8	2.36	0.5
Laharpe	60	2	30.6	2.20	1.0
Lanark	46	-1	26.8	1.71	0.5
Lincoln	60	8	33.5	3.26	T.
Loami	......	......	......	3.38	T.
McLeansboro	67	10	38.1	6.01	4.2
Martinsville	60	7	36.4	4.70	1.5
Martinton	58	10	31.7	3.40	0.5
Minonk	56	2	30.4	1.99	1.0
Monmouth	56	2	29.6	1.76	0.7
Morrison	50	2	28.2	1.55	1.0
Morrisonville	61	6	33.8	2.47	1.0
Mount Carmel	......	......	......	6.04	5.8
Mount Vernon	62	16	38.0	3.18	1.0
New Burnside	68	11	38.0	8.31	0.5
Olney	66	8	37.2	4.19	4.4
Ottawa	57	6	30.9	1.22	T.
Palestine	65	8	37.0	3.35	1.5
Pana	59	7	34.0	2.99	2.0
Paris	62[e]	9[d]	34.6[e]	3.29	......
Philo	60	4	32.3	3.93	1.2
Pontiac	60	6	32.8	2.62	1.0
Rantoul	61	5	33.0	3.08	0.5
Raum	70	12	39.2	8.89	2.0
Riley	48	3	27.6	1.47	1.0
Robinson	63	9	36.8	4.47	0.5
Bockford	43	6	27.0	1.70	2.5
Rushville	58	4	32.6	2.50	0.5
St. Charles	53	6	29.8	2.20	1.0
St. John	67	11	38.5	5.66	T.
Streator	56	9	30.2	3.06	0.3
Sullivan	61	5	33.6	3.80	2.0
Sycamore	50	3	27.2	1.84	1.0
Tilden	65	9	37.4	3.23	1.0
Tiskilwa	54	-2	29.3	2.10	2.0
Tuscola	62	3	32.8	3.58	2.0
Urbana	61	7	32.6	3.13	1.0
Vernon	61	9	36.2	3.19	5.0
Walnut	52	1	29.6	2.52	0.9
Warsaw	......	......	......	1.73	1.1
Windsor	61	3	34.3	3.11	1.1
Winnebago	49	0	27.0	1.59	3.0
Yorkville	52	3	28.8	1.85	0.5
Zion	48	1	26.6	2.08	T.
Indiana.					
Anderson	59	4	32.9	3.81	3.3
Angola	53	1	28.8	4.11	7.5
Auburn	55	-6	27.8	3.60	0.0
Bedford	65	11	38.4	3.00	4.0
Bloomington	62	11	38.0	4.94	8.5
Butlerville	63	1	34.8	5.27	8.3
Cambridge City	60	-2	32.4	3.32	4.0
Columbus	61	2	35.2	4.15	4.2
Connersville	60	-1	33.4	3.32	6.5
Delphi	61	4	31.2	4.35	3.5
Elkhart	57	3	29.9	4.03	7.7
Eminence	60	7	34.5	4.47	2.8
Farmersburg	61	4	35.9	5.69	3.0
Farmland	59	-4	32.0	3.61	3.2
Fort Wayne	60	-3	31.6	3.86	3.7
Franklin	60	4	35.0	3.56	5.5
Greenfield	60	5	33.8	3.37	2.0
Greensburg	61	4	34.6	4.43	9.8
Hammond	54	17	31.6	1.89	2.0
Holland	68	10	39.0	5.77	......
Huntington	55	-2	31.0	3.42	4.3
Jeffersonville	68	16	40.2	5.10	1.5
Knox	56	-4	30.9	4.14	9.0
Kokomo	57	-4	31.5	3.92	3.0
Lafayette	61	8	31.7	4.69	3.2
Laporte	65	-2	29.8	3.61	14.0
Lima	55	-2	28.4	3.38	3.5
Logansport	60	0	32.5	3.96	3.0
Madison	65	9	37.0	5.21	2.0
Marengo	65	9	37.7	7.02	2.0
Marion	58	-5	31.4	4.30	5.2
Markle	58	-6	30.7	4.85	4.5
Mauzy	59	-1	32.5	3.24	6.8
Moores Hill	61	6	34.7	4.03	6.7
Mount Vernon	71	12	37.5	6.70	3.0
Northfield	60	-3	31.2	3.56	4.0
Paoli	65	9	35.4	7.80	9.0
Plymouth	56	-8	30.2	3.21	5.8
Princeton	68	11	38.0	2.65	6.0
Rensselaer	59	10	32.8	4.06	1.5
Richmond	60	-7	32.4	2.60	4.4
Rochester	54	3	31.8	4.08	4.5
Rockville	61	9	33.7	3.95	2.0
Rome	69	13	40.2	5.65	1.0
Salamonia	59	-6	31.6	2.88	3.0

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Indiana—Cont'd.	°	°	°	*Ins.*	*Ins.*
Salem	64	4	36.5	5.43	2.5
Scottsburg	67	10	38.9	5.26	4.5
Seymour	66	5	36.8	5.69	
Shelbyville	59	2	33.7	3.21	2.6
South Bend	54	2	29.0	4.09	9.0
Syracuse	55	— 3	29.9	3.73	6.0
Terre Haute	63	13	37.0	3.92	1.2
Veedersburg	60[f]	14[f]	35.6[f]	3.55	2.0
Vevay	65	8	38.2	3.55	3.0
Vincennes	66	9	35.4	4.74	3.5
Washington	65	11	35.8	4.53	2.8
Worthington	64	4	34.7	4.34	5.0
Indian Territory					
Ardmore	80	21	48.7	1.28	
Calvin				1.71	
Durant	79	22	47.8	1.75	
Fairland	74	7	43.4	1.30	4.0
Fort Gibson				2.35	
Healdton	78	18	47.2	2.83	
Marlow	73	18	46.0	1.34	5.0
Muskogee	72	16	44.6	1.66	T.
Okmulgee	76	17	45.4	1.33	0.5
Pauls Valley	82	18	45.9	0.95	
Ravia	79	22	48.7	1.45	
South McAlester	79	21	48.8	3.23	
Tulsa	77	11	44.2	1.05	3.5
Vinita	73	12	42.8	1.83	4.0
Wagoner	74	14	44.0	1.09	1.0
Webbers Falls	75	21	45.4	1.88	
Iowa.					
Afton	59	— 2	29.6	1.85	T.
Albia	64	— 1	27.6	1.97	1.0
Algona	45	— 6	23.4	0.80	0.5
Allerton	65	0	31.0	1.89	0.5
Alta	46	— 4	23.1	0.85	0.2
Alton	49	— 2	24.9	0.69	1.5
Amana	49	— 2	27.4	2.23	5.5
Ames	51	— 5	27.0	0.70	0.8
Atlantic	55	— 4	28.2	1.30	T.
Audubon	50	— 6	27.0	1.07	
Baxter	49	— 4	26.4	1.41	1.5
Bedford	61	— 4	30.1	1.33	0.2
Belleplaine	47	— 3	23.8	2.22	6.9
Bloomfield	63	0	30.0	2.55	1.5
Bonaparte	59	— 1	29.7	2.20	1.3
Boone	50	— 2	24.5	1.32	0.5
Britt	45	— 6	23.4	0.78	0.8
Buckingham				1.71	
Burlington	59	3	29.3	2.19	
Carroll	51	— 5	24.0	1.04	T.
Cedar Rapids	48	— 3	26.0	1.47	3.8
Chariton	65	— 1	30.1	1.60	T.
Clarinda	65	— 1	28.9	1.22	T.
Clearlake	40	— 3	23.6	0.97	1.3
Clinton	48	3	28.6	2.05	1.0
College Springs	61	— 1	30.6	1.50	
Columbus Junction	55	2	29.8	2.01	1.5
Corning	56	— 3	29.2	1.35	T.
Corydon	65	0	31.4	1.77	T.
Creston	57	1	27.6	0.87	
Cumberland				2.00	
Decorah	44	— 5	23.8	2.02	6.0
Delaware	44	— 1	24.3	1.52	3.0
Denison	52	— 6	27.6	1.07	
Desoto	52	— 5	28.4	1.14	T.
Dows	46	— 6	24.3	1.18	0.8
Earlham	55	— 4	28.8	1.26	T.
Elkader	45	— 7	19.9	2.05	3.5
Elliott	54	— 2	28.6	0.39	
Estherville	50	— 8	20.9	0.37	T.
Fayette	45	— 8	23.7	2.64	6.2
Forest City	46	— 5	20.8	0.50	1.0
Fort Dodge	47	— 4	23.4	1.21	0.5
Fort Madison				1.68	2.0
Galva	46	— 6	25.2	0.86	
Gilman				0.42	1.0
Grand Meadow	42	— 2	23.3	1.96	4.0
Greenfield	56	— 5	28.0	1.59	T.
Grinnell (near)	48	— 3	26.0	1.73	2.2
Grundy Center	48	— 4	26.0	1.70	
Guthrie Center	49	— 6	27.8	0.98	T.
Hampton	47	— 4	24.2	1.52	1.4
Hancock	54	— 1	28.6	0.95	T.
Harlan	52	— 7	26.8	1.23	T.
Hopeville	60	— 1	29.8	1.77	T.
Humbolt	46	0	25.7	0.62	
Independence	45	— 5	23.8	2.81	6.0
Indianola	55	— 1	28.6	2.40	0.2
Inwood	47	— 4	23.3	0.76	1.0
Iowa City	48	— 2	26.5	1.64	3.0
Iowa Falls	45	— 5	23.6	1.54	1.5
Keosauqua	61	— 1	29.1	2.29	2.0
Knoxville	54	1	29.5	1.96	0.5
Lacona				2.54	2.0
Larrabee	49	— 5	24.2	0.40	T.
Leclaire				1.52	0.5
Lemars	48	— 4	24.6	0.98	T.
Lenox	58	— 2	29.6	1.48	T.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Iowa—Cont'd.	°	°	°	*Ins.*	*Ins.*
Leon	62	1	31.0	1.63	T.
Little Sioux	53	— 3	28.4	0.88	
Logan	51	— 2	27.6	1.36	0.5
Maple Valley				6.82	
Marshalltown	48	— 4	24.1	1.23	2.0
Mason City	47	— 2	25.0	1.40	3.0
Massena	55	— 5	27.7	1.51	T.
Mountayr	61	1	30.0	1.48	0.5
Mount Pleasant	58	1	30.0	2.41	1.4
Mount Vernon	46	— 4	26.4	1.95	3.7
Muscatine				1.74	0.7
Nevada				1.14	T.
New Hampton	43	— 5	22.4	1.36	4.0
Northwood	46	— 4	22.6	1.36	6.1
Odebolt	49	— 5	26.7	0.85	
Ogden	49	— 3	26.8	1.05	T.
Olin	46	2	27.4	1.54	2.2
Onawa	49	0	27.4	1.03	0.5
Osage	43	— 4	22.8	1.55	4.1
Oskaloosa	52	— 2	28.6	1.41	0.8
Ottumwa	55	3	29.6		
Pacific Junction	54	— 2	29.2	1.19	T
Pella	54	2	29.1	1.64	T.
Perry	50	— 4	27.2	1.21	0.2
Plover	48	— 6	24.2	0.59	T.
Pocahontas	47	— 3	25.2	0.70	T.
Preston	46	2	27.4	2.37	1.0
Ridgeway	48	— 3	24.4	2.37	6.2
Rock Rapids	50	— 6	21.5	1.05	3.0
Rockwell	45	— 3	26.1		
Sac City				1.21	0.5
St. Charles	62	— 2	30.8	2.15	0.3
Sheldon	50	— 6	25.4	0.60	0.5
Sibley	53	— 5	21.0	0.99	0.8
Sigourney	50	— 1	28.8	2.38	3.8
Sioux Center	47	— 4	24.0	1.12	2.0
Stockport	60	— 2	30.0	2.20	1.0
Storm Lake	47	— 6	23.4	0.77	1.5
Stuart	53	— 2	26.0	1.43	
Thurman	56	— 2	29.6	0.51	T.
Tipton	46	3	28.0	1.86	T.
Toledo	49	— 3	26.6	1.62	1.5
Wapello	54	3	30.0	1.64	1.0
Washington	53	— 2	28.4	2.35	6.9
Washta	50	— 9	25.6	0.60	
Waterloo	46	— 5	26.2	2.10	
Waukee	51	— 4	28.0	2.02	2.0
Waverly	45	0	26.1	1.94	4.7
Webster City	48	— 7	25.9	0.96	T.
Westbend	45	— 7	23.7	0.81	T.
Whitten	47	— 5	25.5	1.70	2.0
Wilton Junction	48	2	28.9	1.75	
Winterset	56	— 1	29.4	2.22	T.
Woodburn	63	0	31.0	2.05	T
Zearing	54	— 5	26.8	1.38	0.4
Kansas.					
Abilene				1.36	
Alton	70	3	35.2	0.83	T.
Anthony	71	15	43.2	0.07	
Atchison	65	7	34.6	0.65	
Baker	60	4	32.5	0.42	
Burlington	69	10	38.8	0.21	T.
Chapman	72	7	36.7	0.92	
Cimarron	72	3	38.2	0.57	T.
Clay Center	64	5	34.8	0.70	
Colby	74	6	37.5	0.35	0.5
Coldwater	69	8	40.8	0.65	T.
Columbus	72	10	40.2	1.70	3.0
Coolidge	72	5	38.4	0.02	
Cottonwood Falls[b]	72	6	37.2		
Cunningham	67	10	39.2	1.25	
Dresden	70	8	36.9	0.44	T.
Eldorado	72	14	39.4	0.56	
Ellinwood	65	10	37.3	0.72	
Ellsworth	67[c]	6[c]	35.2[c]	0.34	
Emporia	67	9	36.2	0.53	
Englewood	75	10	41.4	0.57	
Enterprise	72	7	35.8	0.94	
Eskridge	66	8	35.4	0.83	
Eureka				0.29	
Fall River	72	12	40.0	0.96	
Farnsworth	71	4	37.8	0.23	T.
Fort Scott	70	12	40.6	2.65	
Frankfort	66	3	34.4	0.95	
Fredonia	70	12	40.0	0.91	T.
Garden City	75	9	41.2	T.	T.
Garnett	69	7	36.9	0.90	
Goodland				T.	T.
Gove *[1]	65	8	36.3	0.33	0.2
Grenola	72	12	38.7	0.41	T.
Hanover	65	4	33.4	0.37	
Harrison	61	1	32.4	0.80	0.1
Hays	69	5	36.2	0.51	T.
Horton	64	5	33.2	0.57	T.
Hugoton	75[1]		43.2[j]	0.30	
Hutchinson	68	10	38.5	0.51	
Independence	72	14	40.7	1.12	0.5
Jetmore	69	5	38.4	0.57	T.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Kansas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Jewell				0.83	
La Crosse	68	7	37.2	0.24	T.
Lakin	72	6	38.1	0.19	
Larned	68	8	37.0	0.55	T.
Lebanon				0.50	
Lebo	66	8	36.2	0.40	T.
McPherson	68	10	36.6	1.16	
Macksville	66	10	38.6	0.53	
Madison	72	9	37.8	0.71	
Manhattan *b*	65	5	35.8	0.64	T.
Manhattan *c*	66	7	34.8	1.12	
Minneapolis	67	8	34.2	0.54	T.
Moran	69	11	39.2	0.95	
Mounthope				0.16	
Neosho Rapids				0.88	
Ness City				0.51	T.
Newton	64[e]	8[e]	36.6[e]		
Norton	67	1	34.6	0.80	T.
Norwich	66	12	39.4	0.76	
Oberlin				0.60	1.0
Olathe	66	8	36.2	0.98	T.
Osage City	68[f]	8[f]	38.0[f]	0.87	
Oswego	76	11	40.8	1.58	1.0
Ottawa	68	7	38.4	1.05	
Paola	68	9	37.3	1.56	
Phillipsburg	66	4	34.6	1.20	T.
Plainville				0.65	T.
Pleasanton	68	11	38.4	1.39	
Pratt	70	10	37.3	0.19	
Republic	61	4	32.6	0.83	T.
Rome	73	12	40.4	0.78	
Russell	68	7	36.0	0.59	
Salina	70	6	37.0	0.58	T.
Scott	71	6	38.2	0.14	T.
Sedan	74	9	39.2	1.49	T.
Toronto	73	8	38.4	1.55	
Ulysses				0.35	
Valley Falls	63	6	35.8	0.62	T.
Wakeeney	70	6	37.4	0.56	0.5
Wakeeney (near)				0.45	T.
Wallace	74	3	37.0	0.17	T.
Walnut	72	13	40.4	1.43	
Winfield	70	12	39.0	0.14	
Yates Center	72[f]	9	39.0[c]	0.64	T.
Kentucky.					
Alpha				6.70	1.0
Anchorage	68	7	36.8	5.40	0.5
Bardstown	67	10	39.4	5.17	2.0
Beattyville	69	— 2	38.0	5.77	4.0
Beaver Dam	69	13	38.8	5.60	0.7
Berea	66	1	40.2	6.08	2.6
Blandville	70	16	39.9	7.22	0.8
Bowling Green	70	15	41.9	6.59	2.0
Burnside	68	6	40.5	5.85	1.0
Cadiz	70	14	41.6	5.79	0.5
Calhoun	71	16	41.6	7.20	0.5
Catlettsburg	60	8	38.2	4.42	1.0
Earlington	72	13	40.1	5.06	T.
Edmonton	67	8	40.3	6.28	2.0
Eubanks	63	2	37.1	6.41	3.7
Falmouth				4.57	T.
Farmers	67	— 5	38.2	5.31	3.5
Frankfort	65	8	39.4	5.17	0.9
Franklin	69	16	40.2	6.61	1.5
Greensburg	69	8	38.6	6.92	1.2
High Bridge				5.72	2.0
Hopkinsville	71	14	41.2	7.17	T.
Irvington	68	13	40.1	6.58	1.0
Jackson	67	2	40.4	5.11	2.0
Leitchfield	68	12	39.4	5.37	1.8
Loretto	70	17		4.60	0.8
Lynnville	71	15	42.0	5.42	1.2
Manchester[e]	76	1	37.8		
Marion	70	14	40.0	7.83	1.7
Maysville	67	4	36.1	4.65	1.0
Middlesboro	68	5	40.7	4.32	T
Mount Sterling	65	6	38.2	5.05	
Owensboro	70	17	39.6	6.32	0.5
Owenton	62	9		5.64	3.0
Paducah	70	18	41.1	7.14	1.1
Princeton	71[d]	11[e]		6.56	T.
Richmond	61	5	39.0	6.03	
St. John	67	9	36.8	5.83	2.5
Scott	65	3	35.4	3.97	4.1
Shelby City	64	2	38.0	5.94	2.0
Shelbyville	65	4	35.0	5.20	3.0
Taylorsville	64	8	39.0	5.57	1.5
Williamsburg	69	— 9	39.6	3.86	2.5
Williamstown	63	5	34.0	3.35	3.0
Louisiana.					
Abbeville	81	27	56.5	2.54	
Alexandria	84	26	55.8	4.04	
Amite	81	23	55.0	4.20	
Baton Rouge	83	23	56.0	6.15	
Burnside	82	25	58.4		
Calhoun	80	23	52.4	5.18	
Cameron	76	30	59.2	3.88	
Cheneyville	80	27	57.0	4.41	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Louisiana—Cont'd.	°	°	°	*Ins.*	*Ins.*
Clinton	79	25	56.3	4.36	
Collinston	85	27	52.3	4.71	
Covington	80	23	55.2	4.03	
Crowley	79	28	57.8	4.39	
Donaldsonville	86	28	61.7	3.11	
Farmerville	84	27	52.6	5.05	1.8
Franklin	82	27	58.6	1.69	
Grand Coteau	80	28	59.0	5.50	
Houma	79	24	57.3	2.51	
Jennings	81	29	58.2	5.70	
Lafayette	84	26	58.0	2.33	
Lake Charles	87	30	60.2	3.65	
Lakeside	81	31	58.4	4.05	
Lawrence	84	31	58.4	2.04	
Libertyhill	84	25	53.4	4.73	1.0
Logansport	.....	.....	.....	4.21	
Melville	84	26	56.4	3.65	
Monroe	85	30	55.8	4.32	
Morgan City	.....	.....	.....	1.84	
New Iberia	78	29	59.6	2.25	
Opelousas	82	19	54.4	3.98	
Oxford	.....	.....	.....	6.16	
Pearl River	.....	.....	.....	3.60	
Plain Dealing	82	27	52.4	5.34	T.
Rayne	80	28	58.6	4.77	
Robeline	85	20	53.6	5.65	
St. Francisville	88	24	54.2	6.25	
Schriever	85	23	58.0	2.54	
Simmesport	.....	.....	.....	5.47	
Sugar Experiment Station	78	29	58.6	3.16	
Sugartown	78	25	55.8	5.24	
Maine.					
Bar Harbor	50	− 9	23.0	4.55	27.5
Cornish	44	− 9	19.6	4.15	28.0
Danforth	.....	.....	.....	3.32	18.1
Debsconeag	42	−16	17.7	3.25	32.5
Fairfield	41	−18	15.5	3.55	28.0
Farmington	42	−20	15.2	3.17	28.5
Gardiner	55	−19	18.8	3.41	27.0
Greenville	39	−20	13.4	3.75	29.0
Houlton	50	−22	18.8	.....	.....
Lewiston	45	−11	18.4	3.94	21.8
Madison	45	−20	15.0	5.21	25.0
Mayfield	38	−14	16.0	3.38	21.5
Millinocket	43	−22	14.0	3.35	29.2
North Bridgton	46	−12	18.0	4.32	24.5
Oquossoc	38	−20	15.0	1.96	30.0
Orono	43	−21	17.0	3.37	24.7
Patten	38	−24	14.3	2.73	27.3
Rumford Falls	41	−17	15.8	3.39	21.6
The Forks	.....	.....	.....	2.82	25.1
Vanburen	45	−30	12.0	3.80	26.0
Winslow	42	−19	15.9	2.24	26.0
Maryland.					
Annapolis	65	13	36.6	3.80	T.
Bachmans Valley	62	9	35.5	7.04	T.
Cambridge	68	14	37.8	3.62	0.5
Cheltenham	69	10	35.6	2.73	T.
Chestertown	64	12	36.4	.....	T.
Chewsville	62	8	32.7	3.84	0.5
Clearspring	62[e]	8[b]	30.2[e]	4.51	0.2
Coleman	68	12	36.7	4.19	T.
Collegepark	69	12	35.7	3.38	T.
Cumberland	65	11	33.6	5.44	4.0
Darlington	.....	9[d]	33.7[e]	5.55	T.
Deerpark	57	1	31.8	6.94	14.5
Denton	66	11	37.4	3.17	T.
Easton	65	12	37.2	2.95	T.
Fallston	63	9	34.4	5.11	T.
Frederick	61	11	34.1	4.21	T.
Frostburg	.....	.....	.....	4.15	5.4
Grantsville	57	0	31.1	5.63	13.0
Great Falls	68	10	34.6	2.63	T.
Greenspring Furnace	65	8	32.9	3.84	T.
Harney	.....	.....	.....	4.75	T.
Jewell	68	11	37.4	3.21	T.
Johns Hopkins Hospital	.....	.....	.....	4.05	T.
Keedysville	66	10	34.4	4.07	0.5
Lake Montebello	65	11	34.9	4.49	0.2
Laurel	68	12	35.6	3.68	T.
Monrovia	63	9	34.4	4.24	T.
Mount St. Marys College	.....	.....	.....	6.17	T.
Oakland	58	2	32.2	7.16	12.0
Pocomoke City	66	12	40.4	2.71	T.
Porto Bello	66	12	39.6	1.84	T.
Princess Anne	66	12	38.6	2.75	0.2
Salisbury	68	12	39.2	1.84	0.2
Solomons	67	14	37.9	2.48	T.
Sudlersville	66	11	36.6	3.57	T.
Takoma Park	68	10	33.2	3.34	T.
Taneytown	61	9	33.7	4.58	T.
Van Bibber	63	10	36.6	5.27	T.
Westernport	64	8	34.8	3.93	1.5
Woodstock	66	7	37.1	4.62	T.
Massachusetts.					
Amherst	46	− 3	24.0	4.49	13.0
Bedford	45	− 2	25.6	3.79	14.5
Bluehill (summit)	51	− 4	25.7	3.81	14.0

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Massachusetts—Cont'd.	°	°	°	*Ins.*	*Ins.*
Cambridge	51	− 2	27.1	2.80	.....
Chestnuthill	50	− 1	27.2	5.36	12.2
Concord	48	− 2	24.7	3.89	11.7
Fallriver	54	2	29.2	4.33	10.5
Fitchburg	47	− 4	25.2	4.23	12.0
Framingham	48	− 6	24.2	4.39	10.5
Groton	46	− 6	20.8	4.18	15.0
Hyannis	.....	.....	.....	3.78	5.5
Jefferson	.....	.....	.....	4.28	10.0
Lawrence	48	− 4	24.8	4.00	15.8
Leominster	.....	.....	.....	4.63	12.5
Lowell	45	− 3	25.2	4.22	
Middleboro	55	0	28.4	3.78	6.0
Monson	49	− 2	25.9	3.80	15.0
New Bedford	.....	.....	.....	1.75	.....
Plymouth	53	0	29.2	3.25	3.0
Princeton	.....	.....	.....	4.20	9.5
Provincetown	52	6	33.1	3.02	3.0
Salem	.....	.....	.....	5.26	15.0
Somerset	52	− 4	28.5	5.47	10.0
Sterling	.....	.....	.....	4.37	10.0
Taunton	51	− 1	27.6	4.32	.....
Webster	.....	.....	.....	2.14	8.8
Westboro	48	− 3	28.0	3.75	8.0
Weston	48	− 2	25.8	4.55	15.8
Williamstown	48	− 5	23.8	3.09	9.2
Winchendon	.....	.....	.....	3.47	12.0
Worcester	48	− 3	25.8	3.46	11.0
Michigan.					
Adrian	54	−10	29.2	4.33	5.0
Agricultural College	48	3	26.8	1.85	4.1
Allegan	55[l]	1[l]	28.0[l]	.....	.....
Alma	46	5	26.1	2.53	2.5
Ann Arbor	49	3	27.4	1.58	4.2
Arbela	48	3	26.0	3.79	8.5
Ball Mountain	47	4	25.4	3.99	5.2
Baraga	43	− 5	20.8	2.10	21.0
Battlecreek	55	1	31.2	2.66	3.5
Bay City	48	2	26.2	2.90	8.0
Benzonia[f]	39	7	25.0	.....	.....
Berlin	48	− 1	25.0	3.83	9.5
Big Rapids	45	4	25.9	2.28	6.0
Birchwood	56	− 2	32.0	2.63	6.0
Blaney	39	−10	19.7	2.61	11.1
Bloomingdale	57	2	29.6	1.92	3.5
Calumet	35	− 3	19.0	3.24	40.5
Carsonville	59	4	29.2	1.06	4.5
Cassopolis	54	0	29.0	4.35	4.5
Charlotte	51	− 3	26.5	1.37	6.2
Chatham	34	− 7	19.6	2.56	24.7
Cheboygan	45	− 1	22.6	1.07	6.0
Clinton	51	− 5	27.7	3.87	7.0
Coldwater	55	− 3	29.4	3.69	3.5
Concord	54	− 2	27.2	2.90	T.
Deer Park	37	− 5	20.5	1.15	8.5
Detour	39	−13	19.9	2.31	13.5
Dundee	59	− 9	28.4	3.77	6.0
Eagle Harbor[1]	36	3	22.0	.....	.....
East Tawas	41	− 5	24.0	2.29	5.1
Eloise	49	2	26.6	4.01	8.5
Fennville	50	10	29.8	2.85	2.5
Flint	48	3	26.2	3.00	6.0
Frankfort	42	10	29.0	2.35	13.5
Grand Marais	40	5	23.3	3.27	33.0
Grape	57	− 2	28.4	3.38	5.5
Grasslake	50	− 2	27.2	3.53	7.0
Grayling	42	− 4	21.3	2.75	10.5
Hagar	50	− 8	27.0	6.22	12.0
Harbor Beach	48	2	25.5	.....	.....
Harrison	44	1	22.3	1.80	5.0
Harrisville	46	−10	22.5	1.87	16.4
Hayes	47	− 1	25.7	0.60	6.0
Highland	.....	.....	.....	4.52	7.5
Hillsdale	52	− 1	26.9	3.94	5.2
Holland	51	7	29.6	1.78	4.0
Howell	48	− 3	25.9	3.12	0.8
Humboldt	33	−24	14.2	1.10	11.0
Iron Mountain	43[d]	− 6[d]	22.1[d]	2.05	.....
Iron River	36	−13	15.4	3.00	23.0
Ironwood	34	− 9	17.8	1.64	16.4
Ivan	41	− 5	21.4	1.72	14.0
Jackson	52	− 1	28.3	2.91	4.5
Jeddo	49	4	26.3	2.90	7.6
Kalamazoo	53	7[e]	29.8[e]	.....	.....
Lansing	49	3	27.4	2.69	4.0
Ludington	45[e]	10[e]	28.4[e]	3.25	5.0
Mackinac Island	40	−11	20.0	2.17	16.7
Mackinaw	45	−10	22.6	1.32	13.2
Mancelona	40	− 5	21.4	.....	9.0
Manistee	45	6	27.8	.....	.....
Maple Ridge	36	− 9	19.1	2.80	16.0
Menominee	42	− 1	25.0	1.28	8.0
Montague	45	7	27.2	2.66	7.0
Mount Clemens	53	3	26.6	2.53	2.2
Muskegon	47	8	28.0	1.74	4.0
Newberry	39	.....	.....	0.95	9.5
Old Mission	44	1	25.7	1.16	4.5
Olivet	52	2	26.9	1.44	3.4

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Michigan—Cont'd.	°	°	°	*Ins.*	*Ins.*
Omer	47[e]	− 7	22.2[e]	0.50	5.0
Owosso	49[e]	− 7[e]	28.4[e]	1.93	3.2
Petoskey	42	5	24.7	1.39	10.4
Plymouth	48	− 1	27.6	4.45	5.0
Pontiac	47	4	26.0	4.43	.....
Port Austin	50	2	26.4	1.10	1.0
Powers	38	− 8	21.0	1.40	14.0
Reed City	45	0	24.6	1.29	5.0
Saginaw (W. S.)	48	3	26.3	2.91	7.3
St. Johns	.....	.....	.....	2.55	3.0
St. Joseph	54	9	30.8	3.18	6.0
Saranac	47	− 2	26.3	2.44	4.5
Slocum	43	2	26.6	1.54	.....
South Haven	54	0	28.6	2.77	5.0
Stanton	42	3	24.0	1.80	3.0
Thornville	53	3	28.9	2.85	16.5
Traverse City	41	4[e]	26.6[e]	3.05	10.8
Vassar	45	5	28.0	2.40	6.0
Wasepi	51	− 2	28.0	4.16	3.0
Webberville	49	2	26.4	1.78	3.0
Wetmore	38	− 7	19.0	2.40	24.0
Whitefish Point	36	− 4	21.3	1.94	14.1
Woodlawn	40	−12	18.4	2.68	7.8
Ypsilanti	48	− 5	26.8	3.78	5.0
Minnesota.					
Albert Lea	42	− 6	21.2	0.67	3.0
Alexandria	40	−20	12.6	0.99	5.0
Amboy	53	− 6	22.9	0.73	2.0
Angus	28	−33	4.5	.....	.....
Bagley	34	−35	7.4	1.90	19.0
Beardsley	45	−16	12.9	0.35	1.0
Beaulieu	35	−27	9.2	1.60	16.0
Bird Island	45	−11	19.4	0.53	1.5
Caledonia	41	− 4	22.4	1.51	4.0
Cass Lake	.....	.....	.....	0.37	8.5
Collegeville	38	−15	17.3	0.88	8.9
Crookston	30	−25	7.2	1.90	19.0
Detroit	36	−30	6.9	0.87	13.0
Fairmount	45	− 4	21.4	0.49	1.0
Faribault	40	− 9	20.2	0.68	5.0
Farmington	42	−11	19.8	1.07	11.0
Fergus Falls	38	−15	15.6	1.39	13.9
Fort Ripley	35	−25	11.7	0.72	17.0
Glencoe	43	−10	18.4	0.60	6.0
Grand Meadow	44	− 6	21.6	1.42	6.0
Hallock	25	−36	1.8	1.40	14.0
Hinckley	34	−23	15.4	1.91	.....
Leech	35	−28	10.5	2.48	25.4
Little Falls	37	−18	14.7	0.65	6.5
Long Prairie	37	−24	13.0	0.76	9.2
Luverne	48	− 3	22.4	0.36	1.2
Lynd	50	−10	17.9	0.59	4.0
Mankato	.....	.....	.....	0.19	.....
Maple Plain	41[e]	−15[d]	17.4[e]	1.21	8.7
Milaca	35	−24	13.3	.....	.....
Milan	38	−13	15.6	0.65	5.5
Minneapolis	42	−12	19.9	0.87	6.2
Montevideo	48	10	17.8	0.70	3.0
Mora	35	−25	15.5	1.07	10.0
Morris	40	−15	14.8	0.80	8.0
Mount Iron	35	−26	11.4	1.50	15.0
New London	39	−15	13.8	0.94	2.5
New Richland	45	− 6	22.6	0.35	0.5
New Ulm	53	− 7	22.6	0.27	2.7
Park Rapids	34	−23	9.2	1.50	13.8
Pine River	35	−33	10.8	0.31	10.0
Pipestone	40	− 4	19.8	0.55	0.5
Pokegama Falls	35	−31	10.9	0.87	12.8
Redwood Falls	50	−10	20.6	0.50	2.0
Reeds	.....	.....	.....	0.92	12.7
St. Charles	47	−10	21.4	1.19	.....
St. Cloud	53	−16	15.9	0.54	4.5
Sandy Lake Dam	35	−27	13.0	1.10	14.5
Shakopee	44	−10	21.4	0.75	4.0
Stephens Mine	39	−30	12.6	1.40	14.0
Taylors Falls	40	−18	20.4	3.16	17.5
Tonka	.....	.....	.....	0.53	.....
Two Harbors	39	−20	18.4	0.69	12.0
Wabasha	43	− 8	22.0	1.30	10.0
Wadena	38	−21	12.4	0.27	4.8
Winnebago	.....	− 5	.....	0.88	1.5
Winnibegoshish	37	−28	10.8	1.64	20.0
Winona	42	− 5	21.8	0.94	.....
Worthington	50	− 6	19.7	0.15	1.5
Zumbrota	41	− 8	21.2	0.53	T.
Mississippi.					
Aberdeen	76	19	50.6	3.72	
Agricultural College	75	19	50.8	4.33	
Austin	75	20	49.1	8.97	T.
Batesville	76	21	49.0	4.88	
Bay St. Louis	81	28	57.0	1.74	
Bellefontaine	76	19	49.9	.....	
Biloxi	79	27	58.4	2.13	
Booneville	70	20	47.2	5.69	
Brookhaven	81	22	54.3	3.83	
Canton	79	20	53.2	4.76	
Columbia	.....	.....	.....	4.10	
Columbus	76	20	49.7	4.82	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Mississippi—Cont'd.	°	°	°	*Ins.*	*Ins.*
Corinth	71	20	45.9	5.99	T.
Crystal Springs	80	21	53.6	4.68	
Duck Hill	78	17	49.2	5.42	
Edwards	80	22	54.7	4.67	
Enterprise				5.72	
Fayette	80	22	54.4	5.25	
Fayette (near)				3.49	
Greenville	79	23	50.6	5.68	
Greenwood	78	24	49.9	5.04	
Hattiesburg	83	22	52.9	3.56	
Hazlehurst	81	20	54.8	4.05	
Hernando	73	19	44.8	5.66	T.
Holly Springs	72	20	44.4	5.97	0.8
Indianola	74	22	48.6	6.50	
Jackson	81	23	52.7	3.97	
Lake	78	16	50.4	4.75	
Lake Como	82	22	53.4	5.51	
Laurel	83	22	54.6	4.47	
Leakesville	83	23	54.8	2.14	
Louisville	77	21	52.8	5.81	
McNeill	80	26	55.1	2.38	
Macon	75	20	49.7	5.10	
Magee	77	21	51.8	4.64	
Magnolia	81	23	56.1	4.91	
Merrill				1.86	
Natchez	82	25	55.4	4.56	
Okolona	78	20	46.1	2.89	
Pearlington	77	25	56.5	2.40	
Pecan	82	25	56.5	2.83	
Pittsboro	74	18	48.4	3.80	
Pontotoc	75	18	47.4	2.70	
Port Gibson	82	21	52.4	4.45	
Porterville	76	21	51.8	4.63	
Quitman	78	18	52.9	4.83	
Ripley	75	15	46.8	6.98	
Shoccoe	79	20	53.5	4.65	
Shubuta				3.49	
Stonington				3.94	
Suffolk	79	22	55.4	3.43	
Swan Lake				5.02	
Tchula	78	29	52.9	3.62	
Tupelo	75	20	47.0	3.52	
University	75	22	47.3	4.90	
Utica	82	22	55.7	3.50	
Walnutgrove[h]	77	20	52.6		
Watervalley	75	18	48.6	4.80	
Waynesboro	78	19	52.3	3.85	
Woodville	77	25	55.2	5.21	
Yazoo City	79	24	52.6	3.64	
Missouri.					
Albany				0.70	
Appleton City	67	12	37.8	1.78	
Arthur	70	12	40.6	2.44	
Avalon	67	6	34.6	1.63	
Belle	68	7	37.4	1.97	2.0
Bethany	64	8	34.7	0.76	
Birchtree	62[e]	12[e]	38.8[e]	3.18	T.
Bolivar				2.21	
Boonville				2.42	T.
Brunswick	65	9	32.9	2.14	
Cape Girardeau				5.04	2.0
Caruthersville	73	19	43.8	5.87	1.5
Clinton	67[d]	13[d]	35.8[d]	2.91	
Conception	65	3	31.2	0.84	T.
Darksville	67	5	34.8	1.73	T.
Dean	73	13	43.0	1.01	1.0
Decaturville	65	10	38.7		
De Soto	65	10	37.2	3.76	3.1
Doniphan	70	16	40.8	3.28	T.
Eldorado Springs	67	12	40.4	2.44	
Fairport				0.56	T.
Farmington	64	15	38.0	1.86	T.
Fayette	66	11	35.8	1.53	
Fulton	67[e]	5[e]	34.2[e]	2.63	0.5
Gano	67	5	38.1	2.86	3.8
Glasgow				2.36	
Goodland	64	10	38.0	3.22	1.0
Gorin				3.35	1.7
Grant City	65	1	31.7	0.93	T.
Harrisonville	67	10	34.9	2.42	
Hazlehurst				0.78	
Hermann				2.32	T.
Houston	64	12	39.1	2.23	2.9
Huntsville				1.24	
Ironton	67	10	37.8	3.18	0.4
Jackson	70	15	40.6	5.00	1.0
Jefferson City	66	7	34.7	0.86	0.2
Joplin	74	12	42.6	2.05	1.0
Kidder	64	8	33.4		
Koshkonong	68	15	40.6	4.51	T.
Lamar	72	14	40.8	1.51	1.0
Lamonte				1.73	T.
Lebanon	66	12	38.4		
Lexington	68	10	35.8	1.78	
Liberty	67	8	36.2	1.67	
Lockwood	68	9	40.5	1.34	2.2
Louisiana	68	5	34.4	2.83	2.2
Macon	66	4	33.5	1.65	T.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Missouri—Cont'd.	°	°	°	*Ins.*	*Ins.*
Marblehill	68	14	39.4	5.03	T.
Marshall	67	9	35.0[e]	1.04	
Maryville	66	2	29.7	0.91	T.
Mexico	67	4	32.6	2.64	2.0
Monroe	66	1	31.9	2.11	1.3
Mountain Grove	62	12	38.4	1.99	
Mount Vernon	67	10	40.4		
Neosho	73	7	42.9	1.41	3.0
New Madrid				8.42	
New Palestine	73	9	39.1	1.10	T.
Oakfield	67	8	37.0	1.77	1.7
Olden	69	14	40.6	4.29	T.
Oregon	64	3	31.9	0.60	
Osceola				3.04	
Rockport				0.60	T.
Rolla				1.70	2.7
St. Charles	66	8	35.8	1.91	2.0
St. Joseph				0.56	
Sarcoxie				1.55	2.0
Sedalia	66	11	37.2	1.75	T.
Seymour	66	11	38.5		
Sikeston	70	19	40.7	8.87	1.0
Steffenville	67	0	32.9	1.99	6.0
Sublett	64	1	32.4	2.35	1.0
Trenton	63	6	33.0	1.14	T.
Unionville	62	0	29.0	2.59	T.
Versailles	65	8	36.8	2.00	
Warrensburg	66	10	38.1	2.35	0.2
Warrenton	66	5	33.4	3.08	0.5
Warsaw	67	10	39.6	2.53	T.
Wheatland				0.60	
Willowsprings	61	14	37.3	3.36	1.2
Windsor	64	8	38.0	1.05	3.1
Montana.					
Absarokee				0.45	4.5
Adell	53	−10	27.6	1.90	19.0
Anaconda	52	7	31.3	1.50	6.8
Augusta	60	−17	26.1	1.50	15.0
Babb	46[f]	−21[f]	20.8[f]	1.83	16.6
Billings	65	3	31.9	0.46	10.5
Bowen	45	−15	20.1	2.52	25.2
Bozeman	51	0	28.2	0.43	3.9
Boulder[h]	55	0	27.8		
Broadview	58	−12	25.0	0.48	4.8
Butte	50	2	31.6	0.95	9.5
Canyon Ferry	53	−7	23.4	0.71	2.6
Chester	52	−23	14.4	0.60	6.0
Chinook	63	−15	15.6	1.28	T.
Choteau	60	−15	22.8	0.87	14.0
Clear Creek	65	−13	24.7	1.05	10.5
Columbia Falls	49	3	27.4	3.73	8.5
Copper				1.74	20.5
Crow Agency	48	−18	23.9	0.95	9.5
Culbertson	43	−29	10.2	0.47	6.0
Dayton	46	9	29.0	2.97	17.6
Decker	63	−20	25.2	0.40	4.0
Dillon	53	−6	32.6	1.27	10.3
Ekalaka	54	−7	26.2	0.40	4.0
Ericson				0.18	0.6
Fallon	54	−18	15.5	0.63	7.2
Forsyth	56	−21	23.6	0.70	12.0
Fort Benton	52	−7	21.0	0.80	8.0
Fort Harrison	52[d]	−6	23.6		
Fortine	44	3	27.3	1.70	20.0
Glasgow	40	−24	10.1	1.20	12.0
Glendive	44[d]	−18	16.4	1.06	14.2
Gold Butte				0.85	9.1
Graham	60	−6[d]	29.4	0.35	4.4
Grayling	43	−20	22.4	2.11	35.5
Greatfalls	59	−7	27.0	1.45	10.6
Homepark				1.40	6.0
Huntley	63	0	28.6	0.28	1.8
Jordan	57	−19	17.9	0.90	9.0
Lame Deer	60	−40	24.4	1.30	13.0
Lewistown	51	−5	26.8	1.31	18.5
Livingston	54	3	35.2	0.54	7.0
Lodge Grass	60[k]	−14[k]	24.0[k]		
Marysville	42	−8	22.1	4.00	40.0
Missoula	45	10	29.2	1.72	10.0
Mullets Ranch				2.28	20.8
Nye				0.37	2.9
Ovando	45[d]	−7[d]	24.2[d]	4.45	35.0
Philipsburg	54	−2	31.0	1.22	10.0
Plains	40	13	30.0	0.95	8.0
Polson	48	14	31.7	1.76	5.0
Poplar	49	−25	10.4	2.00	20.0
Raymond				2.23	26.0
Redlodge	59	−3	29.4	0.21	4.2
Renovo	54	2	31.9	0.45	2.2
Ridgelawn	50	−30	12.6	1.20	12.0
Saltese				5.40	34.0
Springbrook	50	−14	19.2	2.46	25.2
Steele	62	−8	27.4	0.67	7.5
Tokna	52	−26	15.3	2.30	23.0
Troy	46	8	29.3	2.52	19.0
Twin Bridges	54[d]	−3[d]	31.0[d]		
Utica	58	−7	28.0	0.68	8.0
Warrick	50[e]	−27[e]	24.0[e]		

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Montana—Cont'd.	°	°	°	*Ins.*	*Ins.*
Wolf Creek	50	−19	27.6	0.56	5.6
Nebraska.					
Agate	60	0	30.9	0.51	2.0
Ainsworth	60	3	29.0	1.26	3.7
Albion	56[k]	−2[k]	26.6[k]	1.86	
Alliance	61	9	33.9	0.70	2.2
Alma	60	2	32.2	0.84	
Anoka				1.14	
Arapaho				1.00	1.0
Arcadia				1.25	1.0
Ashland	55	0	31.0	1.94	0.4
Ashton				0.47	
Atkinson	57	0	27.0	0.71	
Auburn	60	−1	32.0	0.56	T.
Aurora	55	2	31.6	1.20	T.
Beatrice	60	1	32.3	0.96	
Beaver	61	7	34.2	1.19	0.6
Bellevue	54	3	30.4	1.24	T.
Benkleman				0.19	
Blair	52	−2	28.7	1.54	3.0
Bloomfield	48[f]	−2[f]	24.5[f]	1.16	4.0
Bradshaw				1.58	T.
Bridgeport	65	5	34.3	0.20	2.0
Broken Bow	60	1	31.5	1.03	0.2
Burchard				1.10	
Burwell				0.45	T.
Callaway	61	7	31.9	0.96	4.0
Central City				1.02	
Columbus	57	1	28.1	0.94	
Crete	58	1	31.4	0.94	0.2
Culbertson	60	8	33.2	0.84	1.0
David City	53	2	29.5	1.11	T.
Dawson	62	3	32.8	0.49	
Dubois				0.48	T.
Duff				1.00	4.0
Dunning				1.70	2.0
Edgar				0.80	
Ellis				1.00	
Ericson				2.10	2.0
Ewing				0.91	2.5
Fairbury	63	4	34.4	0.75	T.
Fairmont	60	0	28.8	0.93	T.
Fort Robinson	63	7	31.6	0.37	3.7
Franklin	61	1	32.6	0.75	
Fremont	56	−1	27.8	1.12	
Fullerton				1.42	0.2
Geneva	61	2	32.0	0.99	
Genoa (near)	54	1	27.3	1.14	T.
Gosper				1.30	1.0
Gothenburg	66	6	33.7	1.15	2.0
Grand Island	55	8	30.8	1.10	T.
Grant	66	3	34.6	0.41	1.0
Greeley				1.00	
Guide Rock				0.72	T.
Haigler				T.	
Halsey	64	5	30.8		5.1
Hartington	55	−3	25.8	0.56	1.0
Harvard	58	0	29.0		T.
Hastings*[1]	55	7	28.8	0.80	T.
Hayes Center	68	5	34.4	0.90	4.0
Hay Springs	64	2	30.4	1.05	3.0
Hebron	60	2	30.1	0.77	T.
Hendley				1.20	
Hickman				1.25	
Holbrook	60	5	32.0	1.25	2.2
Holdrege	58	6	32.2	1.12	1.0
Hooper*[1]	58	4	27.7	1.06	T.
Imperial	69	5	35.2	0.45	0.2
Kennedy	63	0	31.1	1.40	4.5
Kirkwood	60	2	28.4	1.05	1.0
Leavitt	60	0	28.4	1.24	
Lexington	65	4	31.4	1.58	5.5
Lodgepole	64	5	33.8	0.30	3.0
Loup	57	2	29.2	1.65	2.0
Lynch	62	−5	29.6	0.34	
McCool				1.07	
Madison	59	3	28.8	1.63	T.
Marquette				1.25	T.
Mason				1.40	
Merriman				0.50	5.0
Minden	42	19	30.8	0.92	T.
Monroe				1.14	0.5
Nebraska City	56	−1	31.6	0.95	
Norfolk	61	−3	27.5	1.25	0.5
North Loup	58	2	28.8	1.32	0.8
Oakdale	52	−3	25.3	1.49	0.6
Oakland	54	−4	28.4	1.20	
Odell				0.90	
Ord				1.65	
Palmer				1.10	
Palmyra*[1]	58	0	30.6	0.70	
Pawnee City	65	1	32.2	0.40	
Plymouth	60	3	32.4	0.70	T.
Purdum	64	4	31.0	1.44	0.5
Ravenna	60	2	30.3	1.60	T.
Redcloud	62	2	33.0	0.91	
Republican				0.50	0.5
Rulo				0.30	

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Nebraska—Cont'd.	°	°	°	*Ins.*	*Ins.*
St. Libory				1.53	0.5
St. Paul	57	2	30.4	1.33	1.0
Santee	60	−2	27.6	1.17	2.2
Schuyler				1.06	
Seward	60	0	30.0	1.20	T.
Scottbluff	60	2	33.0		
Springview	54^{c}	-3^{e}	28.2^{e}		
Stanton	59	−6	26.4	1.42	0.5
Strang				1.15	T.
Stratton				0.40	
Stromsburg				1.00	
Superior	65	2	32.8	0.68	
Syracuse				0.55	
Tablerock				0.45	
Tecumseh	65	1	33.8	0.49	
Tekamah	54	−4	26.3	1.33	
Turlington	54	1	30.3	0.89	T.
University Farm	57	0	31.1	0.86	
Wahoo				1.00	T.
Wakefield	56	−4	26.2	0.80	0.2
Watertown				1.04	2.7
Wauneta				0.65	
Weeping Water				0.82	
Westpoint	56	4	27.7	1.08	T.
Wilber				1.00	T.
Winnebago	52	−8	26.2	0.62	T.
Wisner				2.41	
Wymore				0.50	
York	58	1	30.2	1.03	T.
Nevada.					
Amos	58	3		1.62	3.3
Austin	52	8	33.2	1.83	15.0
Battle Mountain	49	23	35.0		
Beowawe *[1]	56	14	34.5	0.30	3.0
Carlin *[1]	52	2	32.6	0.40	4.0
Carson City	56	5	35.1	4.24	18.3
Carson Dam	56	10	35.4	0.94	6.7
Clover Valley	58	0	33.1	0.63	5.7
Columbia	54	7		2.60	21.0
Dyer	55	−21	25.9	1.38	12.0
Elko *[1]	58	8	34.7	0.40	1.5
Ely	59	3		1.00	8.0
Eureka	54	1	32.6	2.49	18.5
Fallon	59	−2	35.9	1.56	5.4
Gardnerville	58	5	34.5	4.55	15.0
Geyser	55^{d}	4^{d}	30.8^{d}	2.16	8.0
Golconda	56	0			
Halleck *[5]	48	−4	30.6	0.35	1.5
Hamilton	60	3	30.4	4.60	46.0
Hazen	60	2		1.24	6.3
Humboldt	52	16	34.7	1.20	9.0
Leetville	58	0		0.70	7.5
Lewers Ranch	56	10	35.8	7.90	27.0
Logan	67	25	47.2	1.13	
Mill City *[1]	60	16	38.6	1.18	11.0
Palmetto	59	−3	31.2	7.31	53.0
Paradise Valley				1.72	5.0
Pioche	52	8	31.9	2.61	15.5
Potts	49	−4	28.7	0.34	2.6
San Jacinto	51	−2		0.95	11.0
Squaw Valley	62	−11	30.6	2.28	18.0
Tecoma	50	−4	31.2	0.42	2.0
Wabuska	62	−1	35.1	1.12	T.
Wadsworth	74	4	40.2	0.80	8.0
Wells *[1]	38	10	25.3	1.20	12.0
New Hampshire.					
Alstead	40	−11	19.0	2.61	14.4
Bartlett				4.64	34.0
Bethlehem	46	−19	15.0	1.89	14.5
Bretton Woods				2.87	18.0
Brookline	46	−12	24.4	3.40	15.0
Durham	44	−11	21.9	3.51	26.0
Franklin Falls	46	−12	19.6	3.75	22.8
Groveton		−23		2.06	19.2
Hanover	45	−19	15.9	2.69	16.2
Keene	45	−12	21.2	3.11	10.2
Nashua	46	−8	21.2	4.05	14.8
Newton	46	−9	22.5	4.47	15.0
North Woodstock				5.08	
Plymouth	44	−17	17.9	2.68	22.2
New Jersey.					
Asbury Park	61	8	35.0	2.92	0.2
Bayonne	57	8	32.6	3.59	1.0
Belvidere	48	5	30.2	5.28	2.3
Bergen Point	57	8	32.2	4.63	1.9
Beverly	63	9	33.2	2.89	T.
Bridgeton	68	10	36.4	4.01	T.
Browns Mills	67	8	35.8		
Canton				3.59	T.
Cape May C. H	64	11	36.9	3.64	T.
Charlotteburg	52	2	30.1	5.63	2.2
Clayton	62	10	35.0	4.20	T.
College Farm	60	4	32.2	3.71	0.3
Dover	50	2	27.7	5.59	4.5
Elizabeth	56	7	33.6	4.38	T.
Englewood	54	6	30.8	3.85	0.5
Flemington	58	7	31.8	4.47	1.0
Friesburg	68	10	36.1	3.93	T.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
New Jersey—Cont'd.	°	°	°	*Ins.*	*Ins.*
Hightstown	64	6	32.8	3.70	0.2
Imlaystown	66	7	33.3	3.29	1.2
Indian Mills	70	9	36.5	3.87	T.
Jersey City	57	8	32.8	4.13	1.4
Lakewood	67	9	35.6	3.27	0.5
Lambertville	60	9	33.7	4.22	T.
Layton	47	−5	27.5	4.13	5.5
Moorestown	65	8	34.2	3.34	0.6
Newark	57	6	32.0	6.18	1.1
New Brunswick	60	9	32.7	4.25	3.0
Newton	48	−2	28.1	3.71	6.0
Oceanic	65	10	35.0	3.99	1.5
Paterson	56	10	33.0	4.83	1.6
Phillipsburg	52	6	30.2	4.98	3.8
Plainfield	56	6	31.3	4.16	1.3
Pleasantville				4.12	
Rancocas				3.43	0.3
Rivervale	59^{d}	0	29.6^{e}	5.43	9.0
Somerville	57	7	31.9	4.26	T.
South Orange	56	7	31.2	4.74	T.
Sussex	47	1	28.8	3.61	3.5
Toms River	70	6	34.7	5.52	T.
Trenton	63	7	35.8	4.89	T.
Tuckerton	57	8	35.9	3.50	0.5
Vineland	67	10	35.4	3.35	0.2
Woodbine	65	10	36.6	3.57	T.
New Mexico.					
Alamagordo	70	23	45.4	2.35	
Albert	74	17	45.4	0.88	
Albuquerque	63^{j}	19^{j}	43.0^{j}	1.20	
Alto				1.91	1.6
Artesia	72	17	46.6	0.85	
Bellranch	68	18	43.4	0.53	
Bloomfield	62	7	37.3	1.39	0.5
Cambray				1.28	
Carlsbad	75	26	47.0	0.98	2.0
Chama	59	3	32.0	3.22	23.0
Cimarron	65	9	37.5	0.84	7.2
Cliff	78	21	45.1	4.86	
Cloudcroft	56	6	33.4	4.73	15.0
Deming	68	26	45.8	1.83	
Dulce	61	1	32.6	1.77	7.3
Eagle Rock Ranch	64	5	37.8	0.45	5.0
Elizabethtown	51	−3	28.4	0.98	8.0
Elk	73	20^{m}	43.6^{g}	1.34	2.0
El Vado	63	−2	33.4	1.27	7.0
Engle	62	19	41.2	2.23	T.
Estancia	65	12	38.0	1.13	2.0
Fairview	67^{f}	16^{f}	41.0^{f}	1.57	1.0
Fort Bayard	66	18	42.2	4.18	T.
Fort Stanton	64	15	40.2	1.68	1.0
Fort Union	64	4	36.4	1.23	7.0
Fort Wingate	60	11	36.8	1.58	3.0
Frisco	65^{d}	15^{d}	39.8^{d}	2.64	T.
Fruitland	60	10	35.0	1.31	T.
Gage	67	25	49.7	2.40	
Glen	75	19	44.7	0.84	T.
Hope				T.	T.
Laguna	67	14	37.2	2.50	T.
Lagunita	72	17	44.5	0.50	T.
Lake Valley				3.04	T.
Las Vegas	66	7	38.2	1.32	5.0
Lordsburg	70	22	47.6	3.42	
Los Alamos				0.92	11.0
Los Lunas	72	15	39.2	1.60	T.
Luna	57	10	34.2	5.72	8.0
Magdalena	64	10	38.8	1.18	T.
Manuelito				1.33	4.0
Mesilla Park	73	20	47.4	1.04	T.
Mimbres				4.94	
Mineral Hill				2.01	8.5
Monument	75	21	48.4	1.10	6.0
Mountain Air	68	11	37.8	2.84	10.0
Nara Visa	70^{f}	19^{e}	46.8^{f}	0.93	
Orange	74	18	44.5	0.28	
Palma				0.28	3.0
Portales	75	20	48.8	0.75	
Red River	44	−6	23.7	1.50	16.0
Redrock				3.67	
Rincon	72	20	46.2	2.63	T.
Rociada	65	5	35.8	0.97	12.0
Rosa				0.67	
Rosedale	59	16	38.8	2.78	1.5
San Marcial	70	19	43.5	1.20	
San Rafael	63	12	38.1	1.70	2.0
Socorro	62	15	40.2	2.37	
Springer	64	7	36.8	0.60	6.0
Strauss				0.65	T.
Taos	60	9	34.3	0.74	2.0
Tres Piedras	52	−1	29.1	1.45	9.5
Tucumcari	69	22	45.4	1.61	
Valley				0.48	T.
Vermejo	70	0	37.0	0.45	6.0
Winsor [1]	63	1	30.6		
New York.					
Adams	48	−22	19.4		
Addison	56	0	27.8	1.70	5.0
Amsterdam	48^{l}	-11^{e}	20.4^{e}	3.16	9.0

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
New York—Cont'd.	°	°	°	*Ins.*	*Ins.*
Angelica	50	−14	25.9	2.49	10.0
Appleton	56	−2	26.6	2.78	10.1
Arcade	50^{d}	-22^{d}	21.9^{d}	2.87	6.0
Athens	47	0	25.8	2.83	3.0
Atlanta	58	0	25.2	2.65	17.0
Atwater				2.77	12.4
Auburn	50	−3	24.6	2.81	19.0
Avon	53	−2	25.7	1.70	13.5
Baldwinsville	46	−7	23.3		
Balston Lake	45	−15	21.8	2.88	9.8
Bedford	53	2	29.0	3.57	7.5
Berlin	48	−8	23.9	2.83	3.0
Blue Mountain Lake				2.83	9.0
Bolivar	53	−12	26.2	3.07	10.4
Bouckville	43	−20	18.2	2.98	12.0
Brockport	52	−3	27.4	2.96	20.0
Cape Vincent	46	−13	20.7	3.80	17.5
Carmel	46	−1	26.1	4.09	5.5
Carvers Falls	44	−20	18.2	3.38	7.0
Chatham	48	−4	24.4	2.08	1.8
Chazy	43	−18	16.6	1.83	16.5
Coeymans	50	−1	25.4	2.40	2.0
Cold Spring Harbor	56	7	30.7	4.82	8.0
Cooperstown	44	−8	22.0	3.85	11.5
Cortland	45	−8	22.5	3.99	11.0
Cutchogue	53	7	31.3	5.77	6.0
Dannemora	45	−23	16.5	3.12	18.2
Dekalb	43^{d}	-22^{d}	14.0^{d}	3.37	25.0
De Ruyter	46	−10	22.8	4.11	17.3
Easton				2.28	8.0
Elba	56	−6	24.0	3.04	15.0
Elmira	55	3	27.6	2.17	3.3
Faust	42	−24	16.0	2.72	23.5
Fayetteville	53	−13	24.0	2.49	8.0
Fort Plain	58	−7	24.8	2.82	8.5
Franklinville	50	−15	24.5	3.18	11.9
Gabriels	43	−27	14.5	1.93	11.0
Gansevoort				4.60	16.0
Glens Falls	44	−16	21.4	4.51	13.2
Gloversville	40	−14	20.0	5.70	17.2
Greenfield	43	−11	20.9	5.00	11.0
Greenwich	45	−13	21.9	2.77	6.0
Griffin Corners	48	−8	23.0	2.68	7.9
Harkness	45	−15	18.2	1.63	12.5
Haskenville				2.07	7.6
Hemlock	51	2	26.8	1.11	3.5
Hunt	55	−9	27.1	2.45	4.0
Indian Lake	44	−27	17.6	2.40	16.4
Ithaca	52	−1	26.2	3.50	13.9
Jamestown	55	2	28.0	4.00	12.0
Jeffersonville	45	−2	24.2	3.61	7.0
Keene Valley	46	−19	17.8	4.22	12.0
Lake George	47	−11	21.4	4.49	15.0
Le Roy	54	−3	24.8	2.76	17.2
Liberty	45	−16	20.1	3.82	6.5
Littlefalls, City Res.	46	−15	20.2	2.28	13.0
Lockport	54	−4	25.8	2.81	11.3
Lowville	44	−14	18.8	2.67	8.0
Lyndonville				1.75	7.2
Lyons	51	−1	25.8	3.40	22.0
Middletown	49	5	27.6	3.97	7.1
Mohonk Lake	49	−1	24.6	5.52	7.0
Moira	45	−20	13.8	3.70	35.0
Mount Hope	56	7	30.4	4.46	10.4
Newark Valley				3.16	12.5
New Lisbon	47	−8	21.8	3.69	8.0
North Lake	45	−23	19.0	3.20	25.0
Norwich	47	−2	26.0	4.73	7.8
Ogdensburg	43	−20	16.0	1.87	11.3
Oneonta	49	−2	25.8	3.23	6.0
Otto	51	−1	25.2	3.06	5.9
Oxford	45	−4	25.1	4.54	13.3
Oyster Bay	62	8	31.4	2.39	3.0
Palermo				1.31	8.1
Perry City	47	−4	23.0	3.00	15.7
Plattsburg	52	−13	18.2	2.19	14.5
Port Jervis	48	1	27.8	3.44	3.0
Potsdam	45	−20	16.3	3.04	19.4
Romulus	52	0	26.8	2.37	13.8
Scarsdale	54	4	29.2	2.05	4.0
Setauket	56	8	32.0	4.07	4.3
Shortsville	53	−1	25.4	2.33	7.8
Skaneateles				3.35	
Southampton	54	8	32.6	3.14	1.8
South Canisteo	54	−2	25.4	2.56	14.0
Spier Falls	45	−14	22.0	5.15	10.5
Taberg	47	−16	21.6	4.85	9.5
Ticonderoga	46	−12	20.0	3.27	10.0
Trudeau	45	−22	15.8	1.99	16.7
Volusia	54	2	26.3	3.16	9.0
Wading River	59	7	31.6	4.67	12.0
Wappinger Falls	48	3	28.8	3.72	5.0
Warwick				2.88	5.0
Watertown	47	−15	19.8	2.42	17.0
Waverly	54	2	27.6	2.47	8.6
Wedgwood	49	−1	23.8	2.88	13.5
West Berne	54	−12	23.2	0.99	8.0
Westfield	56	6	28.4	2.68	6.2

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
***New York*—Cont'd.**	°	°	°	*Ins.*	*Ins.*
Westpoint	48	0	26.8	4.00	1.2
Windham	50	— 8	25.2	1.94	1.8
Youngstown	......	......	......	2.65	13.0
North Carolina.					
Battleboro	......	......	......	3.06	
Beaufort	66	20	48.2	4.07	
Brevard	69	8	42.2	6.36	T.
Brewers	71	14	41.9	3.86	
Bryson City	......	......	......	4.94	2.5
Buck Springs	......	......	......	6.20	2.0
Caroleen	73	17[e]	45.4[e]	4.15	
Chalybeate Springs	74	12	47.3	3.58	
Chapelhill	72	15	42.8	3.54	
Clinton	......	......	......	2.74	
Eagletown	72	14	43.9	3.00	0.2
Edenton	72[d]	19[d]	45.9[d]	3.80	T.
Fayetteville	74	17	47.2	3.69	
Goldsboro	76	17	42.8	4.00	
Graham	......	......	......	2.52	
Greensboro	70	15	41.9	2.55	
Greenville	......	......	......	3.51	
Henderson	70	14	42.6	2.89	
Hendersonville	66	6	41.8	4.04	
Horse Cove	63	12	41.4	7.67	T.
Hot Springs	69	8	42.3	3.38	......
Kinston	77	17	46.7	1.34	
Lenoir	65	10	39.0	2.90	
Lexington	70	13	42.6	3.85	
Lincolnton	76	13	46.1	......	
Louisburg	71	16	43.4	2.55	T.
Lumberton	77	17	45.0	3.31	T.
Marion	70	14	43.6	4.12	T.
Marshall	69	5	41.2	2.82	....
Moncure	74	14	43.9	2.69	
Monroe	81	8	44.6	2.50	
Morganton	68	12	41.7	3.99	
Mountairy	70	10	39.5	3.52	
Mount Holly	......	......	......	4.10	
Murphy	......	......	......	6.18	0.3
Nashville	73	15	44.2	2.89	T.
Newbern	75	16	46.1	3.45	T.
Patterson	65	12	39.8	3.67	T.
Pinehurst	73	16	45.9	3.05	
Pink Beds	62	3	36.9	5.80	0.5
Pittsboro	78	13	47.6	1.40	
Randleman	......	......	......	3.33	
Reidsville	70	15	41.6	2.88	
Rockingham[g]	73	10	46.4	......	......
Salem	68	15	42.5	4.17	
Salisbury	71	12	43.2	4.04	
Sapphire	66	8	40.6	......	T.
Saxon	68	8	41.0	3.56	
Scotland Neck	74	16	45.8	2.84	T.
Selma	70	17	42.2	3.00	
Settle	78	9	45.8	3.52	
Sloan	77	18	45.8	3.87	
Snowhill	76	17	46.2	3.48	
Southern Pines	......	15	......	3.78	
Southport	69	16	48.4	4.10	
Statesville	70	7	42.2	2.80	
Tarboro	74	16	44.6	3.03	
Vade Mecum	69	14	40.8	3.73	
Washington	86	17	47.0	3.70	T.
Wash Woods	72	15	43.8	1.87	T.
Waynesville	65	4	41.4	2.95	1.1
Weldon	72	15	41.7	2.62	T.
North Dakota.					
Amenia	42	—24	7.8	0.40	4.0
Beach	47	—15	18.2	1.36	9.0
Berlin	40	—25	8.6	0.65	6.5
Bottineau	34	—29	5.7	1.22	......
Buford	46	—33	11.2	1.25	12.5
Cando	31	—37	1.8	1.56	15.6
Chilcot	......	......	......	1.10	11.0
Coalharbor	48	—25	9.9	0.80	8.0
Dickinson	47	—24	14.8	0.76	7.6
Donnybrook	35	—29	8.6	1.40	14.0
Edgeley	39	—23	8.1	0.65	6.5
Edmore	33	—35	4.6	1.20	12.0
Ellendale	44	—21	12.8	0.29	......
Fargo	38	—19	9.2	0.27	......
Forman	39	—21	13.0	0.80	8.0
Fort Berthold	45	—34	9.9	0.70	7.3
Fort Yates	51	—21	15.8	0.21	1.7
Fullerton	40	—24	10.2	1.89	18.9
Gladys	42	—24	9.4	1.75	13.0
Glenullin	44	—20	13.4	0.68	7.0
Grafton	30	—28	2.6	1.20	12.0
Hillsboro	34	—23	6.8	1.31	13.1
Jamestown	40	—26	9.4	1.50	15.0
Kulm	40	—21	11.0	1.09	10.7
Lakota	......	—33	......	1.45	14.5
Lisbon	38	—25	9.6	1.30	13.0
McKinney	36	—40	6.4	1.18	11.8
Manfred	34	—31	4.8	1.50	15.0
Medora	......	......	......	1.42	14.2
Melville	38[e]	—26[f]	6.7[e]	......	......
Minot	40	—32	8.0	0.87	8.7

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
***North Dakota*—Cont'd.**	°	°	°	*Ins.*	*Ins.*
Minto	28[f]	—27[f]	6.3[f]	1.58	......
Napoleon	38	—29	9.2	0.56	3.0
New Salem	41	—21	10.9	0.35	3.5
Oakdale	48	—15	12.4	1.10	11.0
Oriska	38	—20	8.4	1.02	10.2
Park River	33	—25	3.0	1.04	10.4
Pembina	42[h]	—34[h]	1.2[h]	1.80	18.0
Portal	35	—28	6.4	1.80	18.0
Power	40	—25	6.4	1.30	13.0
Pratt	38	—37	4.4	1.50	15.0
Steele	39	—25	9.8	0.60	6.0
University	29	—31	4.7	0.87	8.7
Valley City	38	—25	9.0	0.88	8.8
Willow City	30	—37	3.2	1.50	15.0
Wishek	......	......	......	0.20	2.0
Ohio.					
Akron	58	8	31.4	3.23	14.6
Amesville	65	5	34.8	3.82	4.4
Atwater	56	6	......	3.93	6.0
Bangorville	56	— 3	30.0	4.16	9.0
Bellefontaine	57	— 3	31.2	3.97	5.0
Benton Ridge	57	— 9	31.4	3.95	6.7
Bladensburg	60	— 2	32.2	3.45	9.5
Bowling Green	57	—11	29.1	3.37	8.0
Bucyrus	56	— 4	29.2	3.95	3.0
Cadiz	61	2	32.4	3.89	19.2
Cambridge	62	— 2	33.6	3.26	7.0
Camp Dennison	64	— 4	35.4	4.04	9.7
Canal Dover	58	— 2	31.5	3.05	7.0
Canton	57	12	32.2	3.66	11.2
Cardington	61	—15	31.3	3.46	4.6
Circleville	60	— 5	......	2.39	4.8
Clarington	64	5	35.2	5.15	11.5
Clarksville	61	— 3	34.2	4.92	6.3
Cleveland *b*	57	11	31.8	3.53	6.5
Dayton	59	2	33.5	3.62	7.5
Defiance	65	— 4	31.0	3.67	8.7
Delaware	59	— 5	31.6	3.01	4.8
Demos	59	— 1	33.0	4.04	9.0
Findlay	58	— 1	30.8	3.73	4.5
Frankfort	61	— 1	34.4	3.14	5.0
Fremont	59	2	31.2	3.99	7.5
Garrettsville	58	1	30.6	3.90	9.5
Granville	58	0	33.0	3.73	5.8
Gratiot	58	— 2	31.6	3.46	8.6
Green	68	3	37.4	5.19	3.0
Greenhill	57	5	30.3	2.98	6.2
Greenville	59	0	32.2	2.69	3.5
Hedges	56	1	30.3	4.52	7.5
Hillhouse	57	10	30.4	4.02	13.0
Hiram	56	7	29.4	4.33	16.5
Hudson	65	2	29.2	3.35	14.5
Ironton	68	8	38.4	4.20	1.0
Jacksonburg	60	5	34.1	4.34	8.0
Kenton	57	— 3	29.8	3.31	4.5
Lancaster	62	2	34.1	3.54	......
Lima	57	— 2	31.3	3.74	6.0
McConnelsville	63	0	33.7	3.62	8.4
Mansfield	......	......	......	3.25	......
Marietta	63	13	37.4	5.33	2.6
Marion	58	— 3	33.4	3.38	6.2
Medina	57	— 2	30.0	4.15	14.0
Milfordton	67	1	30.3	3.58	6.0
Milligan	63	— 2	33.8	4.31	5.0
Millport	58	1	31.0	3.06	7.7
Napoleon	59	— 2	30.4	4.22	5.0
Nellie	59	4	31.9	3.47	3.5
New Alexandria	62	1	31.4	2.80	6.0
New Berlin	60	3	30.0	3.67	10.0
New Bremen	58	— 1	32.0	2.67	3.8
New Richmond	63	5	36.0	3.88	1.5
New Waterford	57	5	31.2	3.73	9.5
North Lewisburg	58	— 2	31.4	3.10	6.0
North Royalton	56	6	30.7	4.71	14.0
Norwalk	59	— 1	31.4	4.20	6.5
Oberlin	58	5	31.8	3.65	8.5
Ohio State University	60	— 1	32.7	3.03	5.4
Orangeville	56	7	30.2	2.15	4.0
Ottawa	57	— 5	30.9	4.15	7.8
Pataskala	59	— 1	32.0	4.16	8.9
Philo	61	4	33.6	1.90	7.2
Plattsburg	57	— 6	31.8	3.94	11.5
Pomeroy	......	......	......	4.52	......
Portsmouth	67	11	37.2	5.02	1.2
Pulse	65	1	34.2	4.68	3.7
Rittman	56	1	29.4	3.71	6.5
Rockyridge	58	— 3[d]	29.8[d]	3.71	6.2
Shenandoah	58	— 3	30.0	3.37	6.7
Sidney	57	— 1	32.4	3.02	5.4
Somerset	60	1	33.8	3.42	8.5
South Lorain	58	7	32.6	3.43	6.5
Springfield	......	......	......	2.99	5.0
Summerfield	60	1	33.1	4.29	9.5
Thurman	......	......	......	5.22	3.0
Tiffin	58	1	31.5	3.74	7.7
Toledo (St. Johns College)	55	2	29.5	3.36	6.3
Upper Sandusky	58	— 1	31.8	3.05	4.0
Urbana	60	—11	31.0	3.32	7.0

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
***Ohio*—Cont'd.**	°	°	°	*Ins.*	*Ins.*
Vickery	57	2	30.2	3.70	5.2
Warren	57	9	30.9	2.80	9.2
Wauseon	54	— 7	28.6	3.99	8.1
Waverly	65	1	35.6	4.29	4.7
Waynesville	59	1	32.7	3.73	8.0
Wellington	58	9	32.3	3.59	7.5
Willoughby	......	......	......	3.41	4.0
Wilson	64	— 2	36.4	3.92	1.0
Wooster	58	6	31.2	3.79	7.8
Zanesville	......	......	......	3.02	8.1
Oklahoma.					
Alva	68	13	42.8	0.84	......
Arapaho	75	15	43.3	0.80	0.5
Beaver	72	9	42.0	......	......
Blackburn	75[e]	15[e]	42.4[e]	2.06	1.3
Cache	80[e]	12[e]	46.4[e]	0.64	3.0
Chandler	77[e]	......	46.5[e]	1.06	3.0
Chattanooga	77	20	47.9	0.44	T.
Dacoma	70	12	41.9	1.03	
Erick	75	20	50.0	0.88	
Fort Reno	73[e]	10	43.8[e]	0.90	2.0
Fort Sill	76	23	47.3	0.65	1.5
Gage	72	14	40.4	0.70	
Grand	71	17	41.4	0.70	T.
Guthrie	73	16	45.0	0.71	3.1
Harrington	74	13	42.0	0.60	
Helena[g]	72	11	41.0	......	
Hennessey	72	16	45.2	1.32	5.0
Hobart	75	19	45.4	1.21	6.0
Holdenville	76[b]	18[e]	44.2[e]	1.49	T.
Hooker	74	6	41.4	0.63	T.
Jefferson	66	9	40.4	0.65	
Kenton	76	11	41.2	0.82	2.0
Kingfisher	74	15	44.3	0.65	0.5
McComb	76	18	44.4	0.74	T.
Mangum	74	18	42.0	0.70	
Meeker	77	17	46.6	1.20	2.0
Neola	75	17	44.8	0.65	1.0
Newkirk	72	14	41.8	0.64	
Okeene	69	13	43.0	0.71	T.
Pawhuska	76	14	43.3	0.79	2.0
Perry	72	14	42.9	0.83	0.5
Sac and Fox Agency	75[d]	16[d]	45.2[d]	0.58	0.8
Shawnee	77[e]	17[e]	45.8[e]	1.20	2.2
Snyder	75	20	46.2	0.64	1.4
Stillwater	73	14	41.6	0.48	1.2
Taloga	66	15	39.6	0.10	
Temple	75	20	48.4	1.21	2.0
Waukomis	73	13	43.6	1.00	3.0
Whiteagle	75	13	41.6	0.65	2.0
Oregon.					
Alba	......	......	......	2.11	......
Albany	60	26	42.4	......	......
Alpha	......	......	......	12.42	1.0
Ashland	62	27	42.3	3.10	3.8
Astoria	56	32	44.4	14.97	
Aurora (near)	59	26	42.9	5.92	......
Bay City	60	29	44.8	17.77	
Bend	56	12	36.6	0.77	2.5
Beulah	52	4	31.6	2.10	3.5
Blalock	59	22	37.6	2.36	3.0
Buckhorn	61	19	42.5	10.59	0.3
Bullrun	58	29	41.6	12.19	......
Burns	50	5	31.2	1.88	3.0
Carlton	57	23	41.1	7.63	
Cascade Locks	55	26	39.6	13.42	
Coquille	......	......	......	8.91	......
Corvallis	60	24	43.6	6.75	T.
Dale	......	......	......	2.81	5.7
Dayville	57	14	38.8	1.57	......
Doraville	52	26	40.2	9.31	0.3
Drain	63	29	44.4	5.74	......
Echo	60	17	37.2	2.27	2.0
Ella	58	23	36.6	1.64	3.0
Eugene	62	28	44.0	4.75	......
Fairview	63	29	47.7	11.15	3.0
Falls City	55	24	41.2	12.96	
Forestgrove	57	22	39.4	9.19	T.
Gardiner	62	30	48.1	10.79	......
Glendale	58	24	43.6	6.86	1.5
Glenora	54	26	40.2	18.97	12.0
Gold Beach	69	29	48.5	14.80	......
Government Camp	51	19	34.6	7.41	28.0
Granite	51	— 8	32.2	1.76	......
Grants Pass	59	20	42.0	5.29	T.
Grass Valley	46	18	35.7	2.22	5.4
Heisler	62	15	40.0	1.06	T.
Heppner	60	20	37.8	1.78	2.5
Hermiston	......	......	......	1.94	1.5
Hood River	55	27	38.4	7.24	2.0
Huntington	50	11	36.6	1.60	10.0
Jacksonville	60	25	41.4	4.67	4.5
Joseph	53	10	31.6	3.19	21.2
Lagrande	59	11	36.8	3.40	9.5
Lakeview	52	7	33.4	4.17	14.0
Lost River	53	6	33.6	2.04	2.7
McKenzie Bridge	58	21	39.4	8.99	2.5
McMinville	57	23	43.3	7.32	T.

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Oregon—Cont'd.	°	°	°	*Ins.*	*Ins.*
Marshfield	63	29	47.2	10.19	T.
Mill City	60	27	42.4	6.15	T.
Mitchell	60	11	37.4	0.80	.....
Monroe	58[g]	22[g]	44.5[g]	6.50	.....
Mountain Park	51	23	36.0	12.38	14.0
Mount Angel	68	27	44.1	7.30	
Nehalem	.....	.....	.....	19.90	0.5
Odell				2.85	
Olex	57	23	35.8	1.64	3.8
Ontario	.....	.....	.....	2.05	6.0
Paisley	58	6	36.8	0.89	.....
Pendleton	62	21	37.8	2.44	1.0
Port Oxford	58	33	48.0	14.93	
Prineville	55	9	37.0	0.53	.....
Prospect	.....	21	.....	7.05	8.5
Richland	51	11	35.8	2.21	12.0
Riverside	55	— 3	33.8	2.20	2.5
Salem	58	28	43.9	4.65	.....
Silver Lake	63	— 5	31.2	1.68	12.0
Stafford	58	25	43.2	9.01	.....
The Dalles	59	27	39.2	3.07	1.5
Toledo	60	29	45.1	14.25	T.
Umatilla	57	25	38.2	1.74	2.5
Vale	54	2	35.0	1.38	4.0
Van	.....	.....	.....	1.73	9.0
Wallowa	53	6	32.5	3.16	16.5
Warm Spring	63	20	39.0	1.07	T.
Weston	59	19	39.4	3.58	1.5
Williams	60	20	41.2	6.12	T.
Pennsylvania.					
Aleppo	60	— 5	33.7	5.09	7.0
Altoona	59	— 9	28.2	3.80	9.2
Baldwin	56	6	29.7	2.84	5.1
Deaver Dam	.....	.....	.....	3.32	.....
Browers Lock	.....	.....	.....	4.60	.....
California	65	6	35.0	4.42	14.5
Cassandra	58	— 5	30.0	3.26	13.5
Centerhall	48	—10	.....	2.42	13.5
Clarion	.....	.....	.....	3.89	5.5
Claysville	62	— 6	33.1	3.04	14.5
Clearfield	.....	.....	.....	3.37	5.8
Coatsville	62	9	33.2	5.34	0.4
Confluence	.....	.....	.....	7.08	23.0
Davis Island Dam	.....	.....	.....	2.88	9.3
Derry	61	— 7	34.2	4.56	18.0
Doylestown	.....	.....	.....	4.89	.....
Dushore	48	2	26.4	2.57	.....
East Mauch Chunk	52	0	29.5	4.48	7.3
Easton	53	6	31.6	5.06	3.0
Ellwood Junction	.....	.....	.....	3.15	2.4
Emporium	65	3	29.7	3.54	6.5
Ephrata	59	6	31.0	5.53	3.0
Everett	60	— 1	30.6	3.83	4.5
Forks of Neshaminy	.....	.....	.....	4.07	.....
Franklin	57	0	30.4	3.64	7.0
Freeport	60	4	31.7	3.57	6.0
Gettysburg	58	8	32.4	4.23	4.3
Girardville	.....	.....	.....	5.24	14.0
Gordon	52	—10	28.7	4.95	11.0
Greensboro	.....	.....	.....	4.40	8.0
Greenville	57	9	30.9	2.09	12.5
Hamburg	51	6	32.2	5.75	.....
Hanover	60	10	34.6	5.39	2.0
Herrs Island Dam	.....	.....	.....	2.61	6.2
Huntingdon	61	— 4	30.8	4.37	6.0
Hyndman	63	4	33.1	3.98	3.0
Indiana	58	0	30.8	4.65	11.5
Irwin	67	— 6	34.9	4.31	8.7
Johnstown	61	— 2	32.8	5.21	6.5
Kennett	58	10	33.8	4.09	.....
Lansdale	.....	.....	.....	4.29	.....
Lawrenceville	55	— 2	26.9	2.25	8.5
Lebanon	54	7	31.6	4.99	5.5
Leroy	50	— 2	26.0	2.61	9.3
Lewisburg	52	—14	30.1	2.89	7.2
Lockhaven	59	3	29.8	3.25	10.0
Lock No. 4	.....	.....	.....	3.61	T.
Lycippus	60	3	32.8	4.65	18.0
Marion	57	8	31.8	4.65	2.0
Mifflintown	57	— 7	30.2	3.65	5.5
Milford	47	— 2	26.9	3.64	11.1
Montrose	56	— 4	24.3	3.53	13.5
New Germantown	61	— 3	31.4	4.21	2.5
Ottsville	.....	.....	.....	4.45	.....
Parker	.....	.....	.....	3.48	4.5
Philadelphia	62	11	36.0	3.57	0.3
Pocono Lake	59	—12	25.0	3.40	11.0
Point Pleasant	.....	.....	.....	4.49	.....
Pottsville	.....	.....	.....	5.08	.....
Reading	55	10	32.6	5.24	.....
Renovo	.....	.....	.....	2.98	0.6
Saegerstown	56	— 7	29.2	3.93	12.0
Saltsburg	.....	.....	.....	3.26	8.0
Seisholtzville	.....	.....	.....	5.35	.....
Selinsgrove	58	— 6	31.2	4.14	7.0
Shawmont	.....	.....	.....	3.83	.....
Skidmore	60	6	30.4	1.69	8.0
Smiths Corners	.....	.....	.....	4.94	.....
Pennsylvania—Cont'd.	°	°	°	*Ins.*	*Ins.*
Somerset	56	— 4	29.4	4.75	17.3
South Eaton	53	4	29.2	3.88	8.0
Springdale	.....	.....	.....	3.31	6.7
Springmount	.....	.....	.....	4.76	.....
State College	57	— 3	28.4	2.91	14.8
Towanda	52	5	27.8	2.65	6.4
Uniontown	63	7	34.5	5.62	17.8
Warren	56	1	27.8	5.11	11.4
Wellsboro	51	0	27.4	2.04	5.8
Westchester	59	7	32.7	5.61	0.2
West Newton	.....	.....	.....	3.44	8.0
Whitehaven	51	— 1	26.7	4.00	4.2
Wilkesbarre	50	5	30.6	3.49	7.0
Williamsport	54	7	29.9	2.06	4.5
Rhode Island.					
Bristol	51	4	30.2	4.18	5.0
Kingston	52	— 1	28.1	5.82	7.0
Pawtucket	55	6	30.9	2.81	7.5
Providence	54	3	29.6	4.85	9.2
South Carolina.					
Aiken	73	15	48.7	3.70	
Anderson	74	13	46.9	4.39	
Batesburg	75	15	47.6	2.51	
Bennettsville	75	16	49.5	3.45	
Blackville	89	18	47.0	2.36	T.
Blairs	.....	.....	.....	2.08	
Bowman	78	15	48.8	3.39	T.
Calhoun Falls	.....	.....	.....	2.55	
Camden	74	13	47.5	2.24	T.
Catawba	.....	.....	.....	2.56	
Chappells	.....	.....	.....	3.08	
Cheraw	74	16	45.0	3.36	
Clarks Hill	74	12	47.4	3.36	
Clemson College	67	12	44.7	5.97	
Conway	78	17	47.4	3.37	
Darlington	77	15	46.6	3.65	T.
Dillon	78	11	47.6	2.85	
Due West	72	15	47.7	3.82	
Edisto	.....	.....	.....	2.33	
Effingham	.....	.....	.....	1.95	T.
Enoree	.....	.....	.....	3.20	
Florence	77	18	47.1	3.01	
Georgetown	75	18	49.8	3.19	
Greenville	73	13	41.4	5.06	
Greenwood	70	16	44.4	3.80	
Heath Springs	72	13	44.6	3.21	
Kingstree	.....	.....	.....	2.82	
Liberty	76	12	46.0	6.98	
Little Mountain	74	15	48.1	2.79	
Newberry	74	15	46.6	3.12	
Pelzer	.....	.....	.....	4.86	
St. George	76	18	50.2	2.22	
St. Matthews	73	19	46.2	3.50	
St. Stephens	.....	.....	.....	2.70	
Saluda	72	14	47.6	2.59	
Santuck	72	14	46.2	3.26	
Smiths Mills	.....	.....	.....	3.00	
Society Hill	73	17	46.3	3.79	T.
Spartanburg	75	13	44.3	3.84	
Stateburg	76	15	49.7	3.60	
Summerville	79	15	49.9	3.80	T.
Sumter	80	13	53.7	2.66	
Trenton	71	16	48.6	3.64	
Trial	78	14	49.1	3.03	T.
Walhalla	73	12	46.9	7.71	
Walterboro	81	18	52.4	2.95	
Winnsboro	72	14	46.1	1.18	
Winthrop College	70	14	46.2	3.76	
Yemassee	76	17	48.7	2.99	
Yorkville	73	16	47.4	4.06	
South Dakota.					
Aberdeen	53	—21	12.6	0.63	6.4
Academy	53	— 1	24.8	0.86	0.3
Alexandria	60	— 4	21.4	.....	.....
Armour	61	— 3	23.0	1.22	3.2
Ashcroft	55	— 4	23.0	0.60	6.0
Bowdle	47	—18	14.6	0.85	8.5
Brookings	51	— 7	20.2	0.52	2.5
Canton	52	— 4	24.0	0.87	1.0
Castlewood	50	—10	18.2	0.38	2.4
Centerville	54	1	25.6	1.10	3.7
Chamberlain	62	— 4	24.2	0.58	0.4
Cherry Creek	62	—17	18.1	0.93	.....
Clark	48	—14	17.6	0.65	3.3
Desmet	50	— 6	19.8	0.30	0.8
Elkpoint	55	— 2	26.6	1.52	0.4
Fairfax	56	— 3	25.2	0.16	T.
Faulkton	54	—17	15.3	0.81	5.0
Flandreau	50	— 6	20.3	0.42	2.2
Forestburg	56	— 9	19.3	0.58	0.8
Fort Meade	67	— 3	29.3	1.30	13.0
Frederick	45	—25	13.4	2.26	6.8
Gannvalley	47	— 4	21.6	0.45	3.0
Greenwood	63	1	28.2	0.68	2.1
Gregory	65	— 5	28.2	.....	.....
Hermosa	72	0	29.3	1.45	12.5
Highmore	65	—11	19.6	0.40	4.0
Howard	55	— 8	18.8	0.24	2.5
South Dakota—Cont'd.	°	°	°	*Ins.*	*Ins.*
Howell	58	—16	16.3	0.44	2.8
Ipswich	52[h]	—22[g]	11.6[h]	0.70	7.0
Kennebec	61	— 6	24.3	.....	.....
Kidder	41	—22	12.0	0.12	1.2
Kimball	58	— 4	22.4	0.50	.....
La Delle	42	—12	17.1	0.97	7.0
Leola	47	—20	12.4	1.50	15.0
Marion	48	—10	24.4	0.80	5.0
Mellette	45	—20	14.8	0.49	4.2
Menno	56	0	24.9	0.70	2.2
Millbank	50	—13	14.3	0.77	3.2
Mitchell	58	— 3	23.0	1.00	4.0
Oelrichs	58	— 4	26.4	0.85	8.5
Orman	65	— 7	25.7	0.73	6.4
Pine Ridge	68	— 1	33.0	1.40	6.5
Plankinton	56	— 3	22.2	0.87	4.5
Redfield	56	—12	15.4	0.37	2.5
Roslyn	42	—19	13.6	0.47	2.7
Sioux Falls	55	— 1	23.4	0.57	4.5
Spearfish	64	— 4	32.3	0.80	T.
Stephan	55	— 8	19.7	0.70	3.0
Tyndall	60	2	28.0	0.99	1.9
Vermillion	62	0	29.2	0.87	5.0
Warnecke	57	—12	15.5	0.60	6.0
Watertown	46	—10	17.1	0.47	2.9
Wentworth	52	— 5	20.2	0.29	2.1
Whitehorse	54	—18	15.1	0.71	7.1
Woolsey	.....	.....	.....	0.63	0.7
Tennessee.					
Andersonville	67	10	43.0	.....	T.
Ashwood	70	15	44.4	5.20	
Benton	69	11	45.2	4.34	T.
Bluff City	.....	.....	.....	3.39	
Bolivar	72	19	43.0	5.15	0.8
Bristol	61	11	38.2	3.84	2.0
Brownsville	70	21	42.8	7.86	0.3
Byrdstown	67	10	42.0	6.28	1.5
Carthage	70	16	43.8	5.01	T.
Cedar Hill	70	16	42.6	6.90	0.5
Celina	.....	.....	.....	6.17	
Charleston	.....	.....	.....	3.89	
Clarksville	71	16	43.6	7.24	1.0
Clinton	.....	.....	.....	5.90	T.
Covington	70	23	47.0	6.00	
Decatur	70	10	43.0	4.70	T.
Dandridge	.....	.....	.....	4.22	
Dover	74	15	43.4	6.31	T.
Dyersburg	71	21	42.8	8.08	T.
Elizabethton	66	8	40.0	3.66	1.0
Erasmus	65	— 1	40.5	5.81	2.4
Florence	68	14	44.0	4.63	T.
Franklin	68	16	43.2	5.87	T.
Greeneville	66	7	40.4	3.96	0.7
Halls Hill	.....	.....	.....	4.72	T.
Harriman	68	12	42.8	4.70	T.
Hohenwald	72	9	42.4	7.25	0.5
Iron City	71	14	44.8	5.35	
Jackson	71	20	45.8	6.39	1.0
Johnsonville	72	16	44.4	5.63	T.
Jonesboro	69	7	41.3	4.25	3.5
Kenton	71	18	43.5	7.81	6.0
Kingston	.....	.....	.....	3.55	T.
Lafayette	70	10	41.9	5.91	0.5
Lewisburg	71	12	44.1	6.35	0.5
Loudon	.....	.....	.....	4.00	
Lynnville	68	15	45.0	5.99	
McGee	.....	.....	.....	3.51	
McMinnville	68	10	44.0	5.44	3.8
Maryville	69	9	42.3	3.80	T.
Milan	70	19	42.4	7.31	0.2
Monterey	65	8	40.3	6.09	8.5
Newport	67	13	42.0	5.16	2.0
Palmetto	70	12	44.5	5.78	T.
Pinewood	72	13	43.8	5.61	T.
Pope	72	11	44.4	5.90	T.
Rogersville	68	8	39.8	3.25	0.8
Rugby	66	— 4	38.9	7.24	11.0
Savannah	71	17	45.1	5.47	T.
Sevierville	69	7	41.0	4.09	T.
Sewanee	62	9	41.6	7.43	1.0
Silver Lake	61	3	36.8	4.45	4.5
Sparta	68	8	43.9	5.71	1.0
Springdale	71	1	39.2	4.65	2.0
Springville	71	14	41.8	7.09	0.2
Tazewell	.....	.....	.....	4.38	1.0
Tellico Plains	70	11	45.6	3.85	T.
Tracy City	65	10	41.1	6.15	0.5
Trenton	71	18	44.1	7.59	0.5
Tullahoma	68	13	44.5	4.99	T.
Union City	71	19	43.6	5.60	T.
Walling	.....	.....	.....	5.36	.....
Watertown	70	12	44.0	.....	
Waynesboro	70	12	44.5	6.11	T.
Wildersville	69	20	45.2	6.93	T.
Yukon	68	16	45.0	4.42	
Texas.					
Albany	82	22	51.2	0.20	2.0

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Texas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Alvin	.....	.....	.....	1.61	
Arthur	.....	.....	.....	2.56	
Austin	76	35	57.4	3.95	0.4
Ballinger	85	22	55.4	0.50	0.5
Barstow	74	27	48.1	0.92	6.0
Beaumont	.....	.....	.....	2.86	
Beeville	83	31	61.2	1.21	
Big Springs	76	26	50.0	0.51	3.7
Blanco	80	28	53.6	1.17	0.8
Boerne	78	26	55.2	3.00	2.0
Bonham	79	28	52.4	2.27	
Booth	.....	.....	.....	2.10	
Bowie	78	21	49.4	0.55	T.
Brenham	80	34	57.0	2.58	
Brighton	79	34	63.0	0.45	
Brownsville	84	39	66.0	1.30	
Canadian	70	25	44.3	0.72	
Channing	72	22	46.2	0.00	
Childress	75	21	46.8	0.15	T.
Claude	70	18	46.4	0.00	
Claytonville	78	28	56.8	0.30	3.0
Coleman	80	27	54.1	0.85	
College	81	36	59.0	3.66	
Colorado	80	24	51.2	0.62	2.0
Columbus	.....	.....	.....	1.55	
Corsicana	79	31	53.4	4.46	
Crockett	82	30	56.8	5.00	T.
Cuero	87	33	62.1	1.67	
Dallas	83	27	51.6	2.08	
Danevang	84	31	59.2	1.25	
Denison	.....	.....	.....	1.10	
Dialville	76	30	55.0	7.07	1.0
Duval	80	32	56.2	4.86	T.
Fort Clark	80	30	58.6	0.70	
Fort McIntosh	90	35	66.2	0.20	
Fredericksburg	78[e]	27[e]	54.0[e]	1.30	T.
Gatesville	78	25	54.6	2.05	
Georgetown	81	28	56.0	3.68	.....
Gonzales	.....	.....	.....	1.53	
Graham	.....	.....	.....	0.63	1.2
Grapevine	81[e]	25[e]	53.0[e]	1.91	
Greenville	.....	.....	.....	3.19	
Hallettsville	82	35	60.0	2.12	
Haskell	79	23	48.2	0.50	1.5
Hebbronville	.....	.....	.....	0.00	
Hempstead	.....	.....	.....	1.65	.....
Henrietta	83	14	46.0	0.94	2.9
Hewitt	.....	.....	.....	3.70	T.
Hillsboro	79	23	53.4	3.13	1.0
Hondo	79	28	58.8	1.31	2.0
Houston	81	34	60.5	3.31	
Huntsville	80	30	56.2	3.17	
Jefferson	80	27	53.6	7.67	
Kaufman	80	31	52.8	5.23	
Kent	76	26	53.2	0.80	4.0
Kerrville	.....	.....	.....	2.10	T.
Knickerbocker	79	24	52.4	0.53	
Kopperl	.....	.....	.....	1.50	
Lampasas	82	24	52.6	3.38	
Liberty	82	31	59.4	4.30	
Llano	78	29	56.1	1.50	
Longlake	.....	.....	.....	7.13	
Longview	79	31	52.5	7.03	
Lufkin	83	30	56.8	3.48	
Luling	80	32	57.8	4.85	.....
Mexia	78	29	52.5	6.18	0.9
Miami	70	21	44.2	T.	
Mount Blanco	76	23	48.3	0.36	0.3
Nacogdoches	80	27	53.9	3.60	.....
Nazareth	73	22	45.0	0.14	.....
New Braunfels	77	34	58.3	3.60	3.0
Orange	.....	.....	.....	1.10	
Panter	.....	.....	.....	2.04	
Paris	85	24	54.4	2.32	
Pierce	87	31	60.0	1.30	
Plemons	72	15	43.0	0.50	
Port Lavaca	81	32	61.9	0.58	
Rhineland	81	21	49.0	0.30	3.0
Riverside	.....	.....	.....	3.50	
Rockisland	89	34	59.0	1.42	
Rockland	.....	.....	.....	4.60	
Rockport	78	40	63.0	0.00	
Sabinal	82	29	57.4	0.84	1.0
San Marcos	77	31	56.6	2.06	T.
San Saba	78	27	53.8	0.94	
Santa Gertrude	.....	.....	.....	1.35	
Seymour	79	23	49.5	0.84	0.3
Sherman	80	26	54.4	1.28	
Sonora	80	25	53.3	0.69	.....
Sulphur Springs	79[e]	26[e]	53.0[e]	4.81	
Temple	78	27	51.8	4.25	.....
Tilden	88[f]	26[f]	59.9[f]	0.66	
Valley Junction		.....	.....	2.40	
Victoria	83	32	59.2	0.80	
Waco	80	30	56.6	5.02	
Waxahachie	81	25	51.2	3.97	0.8
Weatherford	76	25	51.6	1.02	.....
Willspoint	80	26	52.6	4.37	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Utah.	°	°	°	*Ins.*	*Ins.*
Alpine	.....	.....	.....	2.57	3.0
Alta	.....	.....	.....	6.65	53.0
Aneth	62	14	39.0	1.08	.....
Beaver	73	17	44.9	0.70	7.0
Blackrock	63	8	35.0	0.97	3.0
Castledale	57	8	33.3	1.88	.....
Castle Rock	.....	.....	.....	1.70	14.0
Cedar City	58	8	35.8	1.31	3.4
Corinne	59	15	34.8	3.02	2.0
Deseret	65	5	34.0	0.94	3.0
Emery	65	9	32.6	1.70	11.0
Enterprise	.....	.....	.....	3.68	8.0
Escalante	53	10	32.6	2.99	
Farmington	59	15	37.6	2.39	16.5
Fillmore	66	11	37.4	0.63	
Fort Duchesne	41	— 8	18.7	0.60	6.0
Frisco	55	0	31.0	0.95	.....
Garrison	64	12	35.4	0.58	.....
Government Creek	55	6	34.0	1.28	3.5
Grayson	58	12	36.8	4.15	9.0
Heber	48	— 6	29.2	2.45	7.2
Henefer	51	— 5	30.4	1.86	5.8
Hite	69	26	42.2	0.76	.....
Huntsville	.....	.....	.....	3.48	12.0
Ibapah	49	— 1	26.8	0.22	1.2
Kelton	.....	.....	.....	1.21	3.0
La Sal	55	8	33.0	0.21	T.
Levan	59	6	32.5	1.71	5.6
Loa	46	— 6	25.6	0.45	2.0
Logan	55	10	33.6	1.99	6.4
Manti	60	2	31.5	1.53	1.0
Marion	.....	.....	.....	2.49	12.0
Marysvale	66	8	33.2	1.45	7.6
Meadowville	50	2	29.8	1.55	4.0
Milford	58	11	33.9	1.43	7.8
Millville	.....	.....	.....	1.57	.....
Minersville	.....	.....	.....	2.14	13.0
Moab	58	16	38.0	1.57	.....
Morgan	57	— 5	33.5	1.81	6.5
Mount Nebo	62	9	37.3	1.09	1.0
Mount Pleasant	59	4	33.3	1.28	9.0
Nephi	.....	.....	.....	1.36	2.5
Oak City	61	9	35.8	1.64	.....
Ogden	54	14	36.3	2.63	6.3
Panquitch	.....	.....	.....	0.66	
Park City	54	— 3	29.0	2.12	6.0
Parowan	58	4	32.0	1.18	9.6
Payson	.....	.....	.....	1.44	9.0
Pinto	56	— 2	30.4	2.85	3.0
Plateau	54	— 2	31.2	1.27	8.8
Provo	58	9	35.0	2.75	9.0
Ranch	53	— 4	29.7	3.51	
Randolph	.....	.....	.....	1.21	.....
Richfield	66	15	36.6	0.41	
Rockville	.....	.....	.....	2.66	
St. George	68	23	41.6	.....	
Salt Air	60	14	36.0	1.15	0.5
San Juan	.....	.....	.....	1.99	
Scipio	63	— 2	34.7	1.44	2.0
Snowville	58	2	31.0	2.47	
Sunnyside	.....	.....	.....	0.57	2.0
Theodore	47	— 8	20.6	0.70	6.0
Thistle	58	— 4	34.8	1.50	9.0
Tooele	60	15	37.4	0.75	
Tropic	54	4	33.7	2.89	10.7
Trout Creek	60	6	34.0	0.15	1.5
Vernal	48	1	22.5	1.72	11.5
Woodruff	48	—12	25.2	0.84	8.4
Vermont.					
Bloomfield	40	—26	14.0	1.90	27.7
Cavendish	44	—13	18.9	2.23	16.0
Chelsea	41	—19	15.2	4.11	34.0
Cornwall	43	—11	19.8	2.20	19.0
Enosburg Falls	46	—25	15.4	2.46	36.1
Jacksonville	44	—15	18.8	2.55	26.0
Manchester	46	—11	21.1	2.08	10.5
Norwich	42	—18	15.7	3.87	24.0
St. Johnsbury	40	—24	14.7	2.75	24.0
Wells	42	—12	18.5	3.13	13.5
Woodstock	40	—24	15.6	3.51	21.0
Virginia.					
Arvonia	73	8	40.6	2.07	T.
Ashland	71	14	40.6	1.34	T.
Barboursville	71	12	39.8	2.90	T.
Blacksburg	68	10	35.6	3.04	1.0
Buchanan	.....	.....	.....	1.60	1.0
Burkes Garden	59	3	34.8	4.65	6.0
Callaville	71	9	43.7	4.15	
Charlottesville	71	11	35.6	3.17	1.0
Clarksville	.....	.....	.....	2.40	
Columbia	72	13	40.8	2.45	T.
Dale Enterprise	70	6	36.5	3.57	2.0
Danville	.....	.....	.....	2.79	
Dinwiddie	70	7	41.0	3.69	0.2
Doswell	73[e]	8[e]	42.4[e]	2.21	
Elk Knob	62	1	37.5	4.75	5.0
Fredericksburg	72	8	38.2	2.71	T.
Grahams Forge	65	9	38.4	1.91	1.0

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Virginia—Cont'd.	°	°	°	*Ins.*	*Ins.*
Hampton	65	20	42.1	1.19	
Hot Springs	65	9	34.3	3.43	1.5
Ivanhoe	.....	.....	.....	2.13	1.1
Lexington	72	13	37.0	3.08	2.0
Lincoln	65	8	33.4	3.84	T.
Marion	63	8	37.8	3.65	5.0
Mendota	.....	.....	.....	3.32	0.1
Newport News	68	15	42.8	3.41	T.
Nokesville (near)	68	12	36.8	2.67	T.
Petersburg	72	10	40.4	3.19	T.
Quantico	70	12	36.9	2.43	T.
Radford	.....	.....	.....	3.68	2.0
Randolph	.....	.....	.....	2.70	.....
Riverton	.....	.....	.....	3.74	
Roanoke	68[f]	9[f]	41.8[f]	1.60	T.
Rockymount	68	14	40.5	2.18	
Shenandoah	.....	.....	.....	2.79	1.2
Skyland	.....	.....	.....	3.98	6.2
Speers Ferry	.....	.....	.....	6.23	5.0
Spottsville	70	15	42.9	3.70	T.
Staunton	69	10	39.8	3.17	4.0
Stephens City	69	9	35.4	3.36	
Warsaw	70	10	39.9	2.55	T.
Williamsburg	69	21	44.7	5.25	T.
Woodstock	66	10	36.5	3.23	1.0
Washington.					
Aberdeen	57	30	42.4	11.22	T.
Anacortes	55	25	41.5	4.47	
Ashford	.....	.....	.....	12.42	2.8
Baker	54	24	38.8	9.78	1.9
Bellingham	62	23	41.8	5.43	3.0
Bogachiel	62	29	42.1	17.69	1.0
Brinnon	54	28	40.0	10.09	1.0
Cedar River	.....	.....	.....	8.56	3.3
Centralia	57	27	41.7	7.28	
Cheney	51	13	32.3	2.80	12.5
Clearbrook	55	17	37.7	5.76	7.5
Clearwater	54	30	41.4	18.96	0.8
Cle Elum	44	12	29.8	4.94	21.0
Colville	42	9	29.4	2.79	20.0
Conconully	41	4	26.0	3.19	31.3
Coupeville	62	27	42.4	3.01	T.
Crescent	42	13	29.5	3.29	18.0
Easton	.....	.....	.....	6.60	40.0
East Sound	58	24	40.5	4.54	3.0
Ellensburg	44	— 2	28.9	2.81	28.1
Ephrata	48	6	29.4	0.96	9.0
Fort Simcoe	47[1]	17[1]	33.1[1]	3.26	.....
Goldendale	57	15	36.1	3.36	2.5
Granite Falls	.....	.....	.....	8.87	
Hatton	48	12	32.4	2.41	8.6
Kennewick	56	16	36.1	1.78	3.0
Kiona	54	16	34.9	2.01	3.5
Kosmos	52	28	39.9	12.05	4.0
Lacenter	58	22	40.0	9.40	T.
Lakeside	49	18	31.0	3.22	42.5
Lester	50	24	36.4	7.55	26.0
Loomis	47	5	33.0	1.50	15.0
Lovings Ranch	60	30	45.2	13.83	1.0
Matlock	53	23	39.4	15.31	2.0
Mottinger Ranch	56	26	37.8	2.24	3.3
Mount Pleasant	58	30	41.4	8.79	
Moxee	55	11	31.6	2.12	12.4
Northport	38	2	27.6	.....	.....
Odessa	46	17	29.6	1.36	.....
Olga	57	25	41.8	5.34	T.
Olympia	.....	.....	.....	10.48	5.5
Pinehill	54	27	37.4	5.07	3.5
Pomeroy	66	20	35.6	4.83	6.0
Port Townsend	58	31	42.4	2.33	
Pullman	49	17	34.3	5.71	14.8
Quiniault	54	31	40.9	18.75	
Rex Creek	47[h]	25[h]	34.8[h]	4.61	32.0
Ritzville	.....	.....	.....	3.26	13.4
Rock Lake	.....	.....	.....	4.05	8.0
Rosalia	47	9	32.6	3.97	9.5
Ruby Hill	41	7	25.7	4.04	35.3
Sedro	58	25	40.2	6.32	
Sixprong	56	24	35.1	2.37	3.0
Snohomish	56	24	40.6	8.06	T.
Snoqualmie	56	27	39.7	7.49	
Stokes	47	8	25.7	3.80	46.5
Sunnyside	50	20	33.5	2.50	7.0
Twisp	45	— 9	23.7	3.56	44.5
Union	59	27	40.6	12.95	3.0
Vancouver	61	23	41.8	6.92	
Vashon	56	28	42.4	7.51	T.
Wahluke	52	20	33.6	2.24	9.2
Waterville	38	4	26.2	3.10	31.0
Wenatchee (near)	44	12	28.2	3.56	35.0
Wilbur	42	9	27.2	3.29	14.0
Yale	57	24	41.7	19.37	2.0
Zindel	57	22	40.8	2.34	T.
West Virginia.					
Bancroft	67	9	36.9	4.88	1.6
Bayard	59	3	33.0	7.51	13.0
Beckley	64	8	36.6	4.64	9.0
Bens Run	65	9	35.8	5.60	7.0

TABLE II.—*Climatological record of cooperative observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
West Virginia—Cont'd.	°	°	°	*Ins.*	*Ins.*
Berkley Springs	65	8	33.6	3.51	1.5
Burlington	67	7	34.3	4.32	6.0
Cairo	67	5	36.4	6.04	4.0
Central	64	6	35.0	4.51	3.8
Charleston	70	10	42.6	4.90	1.5
Creston	64	7	35.7	5.46	0.8
Cuba	66	2	36.8	4.40	2.6
Davis	.....	.....	.....	7.90	T.
Elkhorn	65	9	38.5	2.91	3.0
Fairmont	63	8	35.8	4.74	3.5
Franklin	67	10	37.7	3.26	T.
Glenville	66	11	37.8	5.82	5.0
Grafton	63	8	36.2	5.59	10.5
Green Sulphur Springs	66	10	35.6	2.78	.....
Harpers Ferry	.....	.....	.....	3.19	.....
Hinton	66	13	36.8	2.62	1.5
Huntington	68	8	36.8	4.00	1.8
Leonard	56	6	33.1	4.20	4.0
Lewisburg	65	3	35.2	3.18	1.5
Logan	69	14	42.0	6.44	7.0
Lost City	64	10	36.3	3.00	T.
Lost Creek	65	9	36.6	4.74	1.5
Mannington	61	6	35.4	5.07	5.5
Martinsburg	65	9	31.3	3.90	.....
Moorefield	70	7	35.4	3.10	3.0
Mooresville	.....	.....	.....	4.60	4.0
Morgantown	62	8	35.4	5.48	11.5
Moundsville	64	2	35.2	4.35	6.7
New Cumberland	60	0	31.8	1.83	5.0
New Martinsville	62	9	36.4	5.42	3.5
Nuttallburg	60	7	33.5	3.65	17.0
Oceana	65[d]	12[d]	38.6[d]	5.46	7.5
Parsons	65	−1	34.6	5.26	4.7
Philippi	63	4	35.8	6.27	11.6
Pickens	56	2	31.5	9.61	42.0
Point Pleasant	66	9	39.0	4.05	1.0
Powellton	69	10	39.8	2.08	4.0
Princeton	62	4	34.6	4.15	8.0
Romney	64	10	33.6	3.34	1.5
Rowlesburg	.....	.....	.....	7.63	10.2
Ryan	67	7	37.9	4.48	2.0
Smithfield	61	8	33.2	7.38	9.0
Southside	65	5	37.4	4.55	2.0
Spencer	67	4	35.4	4.23	2.9
Sutton	68	10	36.5	5.50	4.0
Terra Alta	60	2	31.0	11.15	18.5
Union	69	2	35.6	2.59	2.0
Uppertract	69	8	37.4	2.95	.....
Wellsburg	60	1	32.2	3.47	14.0
Weston	66	12	36.0	6.08	8.5
Wheeling	.....	.....	.....	3.10	.....
Williamson	67	12	40.4	6.28	10.0
Wisconsin.					
Amherst	44	−6	21.6	2.56	3.8
Appleton	39	−1	24.2	1.64	4.7
Appleton Marsh	41	−11	21.3	1.07	4.8
Antigo	36	−10	20.8	0.43	4.5
Ashland	35	−11	20.0	1.71	16.3
Beloit	48	5	28.1	.....	.....
Brodhead	45	−4	26.4	2.04	1.5
Burnett	41	−3	24.0	1.65	2.0
Chilton	41	−1	24.1	1.47	4.2
Chippewa Falls	.....	.....	.....	2.25	1.7
Downing	38[a]	−17	17.4[b]	1.80	18.0
Eau Claire	41	−11	20.8	1.33	13.0
Florence	37	−8	18.2	2.40	18.0
Fond du Lac	52	−3	26.0	1.59	3.0
Grand Rapids	40	−10	22.1	1.31	5.5
Grand River Locks	.....	.....	.....	2.22	6.0
Grantsburg	38	−20	17.3	1.60	16.0
Hancock	37	−9	22.0	0.20	2.0
Harvey	45	−1	25.5	1.59	1.4
Hayward	36	−26	15.9	1.35	12.0
Hillsboro	44	−11	22.4	1.20	3.0
Koepenick	45	−15	20.8	1.50	15.0
Lancaster	.....	.....	.....	1.45	3.5
Manitowoc	44	1	27.8	2.08	5.5
Mauston	40	−6	24.1	1.23	3.5
Meadow Valley	41	−10	21.6	0.83	5.0
Medford	44	−13	20.6	1.20	12.0
Menasha	.....	.....	.....	1.13	5.0
Merrill	38	−12	19.6	1.38	8.0
Minocqua	35	−15	17.7	.....	.....
Mount Horeb	42	−2	24.0	1.32	4.0
Neillsville	40	−12	24.2	1.20	12.0
New London	42	−5	23.6	1.98	8.0
New Richmond	44	−15	20.2	1.10	11.0
Oconto	40	−4	24.4	2.59	4.5
Osceola	41	−15	19.4	1.97	10.0
Oshkosh	40	−1	24.0	1.98	3.0
Pine River	41	−9	23.0	2.26	5.7
Portage	40	−4	24.7	1.74	4.0
Port Washington	43	2	26.2	2.00	2.5
Prairie du Chien	45	−3	26.4	1.82	2.0
Prentice	40	−19	18.8	1.53	14.8
Racine	48	−5	29.8	1.44	.....
Sheboygan	43	4	28.5	1.70	5.0
Wisconsin—Cont'd.	°	°	°	*Ins.*	*Ins.*
Shullsburg	45	−3	25.8	2.10	T.
Spooner	38	−22	16.6	1.80	18.1
Stanley	39	−15	20.2	1.81	16.8
Stevens Point	40	−11	19.8	2.20	8.0
Sturgeon Bay	41	4	25.8	3.60	11.0
Valley Junction	49	−10	21.8	1.18	6.5
Viroqua	41	−5	22.6	1.79	4.5
Watertown	43	−3	24.2	1.53	1.0
Waukesha	.....	.....	.....	1.31	0.2
Waupaca	41	−8	23.5	1.82	7.0
Wausau	38	−7	21.5	1.31	15.5
Weyerhauser	39	−16	18.3	1.88	15.3
Whitehall	53	−16	21.4	1.03	10.3
Wyoming.					
Afton	50	−15	28.2	2.45	11.0
Barnum	.....	.....	.....	1.00	6.0
Barret Creek	65[f]	−12[f]	25.3[f]	2.46	24.2
Bedford	50	−20	25.6	2.05	16.8
Blue Cap	44[e]	.....	29.6[e]	2.10	21.0
Border	46	−23	23.0	1.68	.....
Chugwater	60	10	35.2	0.55	0.5
Clark	62	2	34.2	0.22	4.0
Clear Creek Cabin	56	−14	26.2	2.76	25.5
Daniel	45	−23	17.8	2.10	21.0
Dubois	.....	.....	.....	0.26	2.6
Elk Mountain	.....	.....	.....	1.94	23.0
Embar	60	−2	28.0	1.38	3.0
Evanston	48	−10	26.7	1.04	9.5
Experiment Farm	.....	.....	.....	0.10	T.
Fontenelle	42	−24	19.4	0.85	8.5
Fort Laramie	61	4	33.7	0.48	10.0
Fort Washakie	55	0	28.5	0.10	.....
Granite Canyon	56	7	32.6	0.25	3.0
Granite Springs	60	10	35.0	0.14	1.0
Green River	48	−12	22.6	1.67	7.0
Griggs	59	4	33.4	1.15	6.8
Hatton	.....	.....	.....	0.50	5.0
Hyattville	60	−2	32.5	.....	.....
Jackson	44	−27	24.8	1.09	1.1
Kirtley	54	6	28.1	0.81	19.0
Laramie	56	4	30.4	0.39	6.0
Leo	53	5	31.2	0.88	5.8
Little Medicine	48	−9	23.9	1.31	16.0
Lolabama Ranch	53	−2	29.0	0.47	4.1
Lusk	60	8	31.4	0.40	4.0
Moorcroft	63	−5	30.6	1.20	12.0
Moore	61	10	35.2	0.35	1.0
New Castle	56[g]	0[g]	31.0[g]	0.75	7.5
Pathfinder	55	10	33.6	0.45	5.2
Phillips	63	3	34.4	0.49	2.0
Pine Bluff	67	2	34.8	T.	T.
Pinedale	41	−20	19.2	0.95	13.5
Rawlins	51	4	29.6	0.57	4.5
Sheridan	67	−8	29.2	0.70	7.0
Shoshone Canyon	55	0	33.4	0.10	1.0
South Pass City	37	−18	15.2	0.80	8.0
Wells	38	−30	17.1	1.00	13.0
Wheatland	66	11	38.8	0.80	.....
Wolf	64	−1	35.2	0.60	6.0
Wyncote	59	8	33.6	0.48	.....
Yellowstone Pk. (F'tain)	50	−21	22.6	.....	.....
Yellowstone Pk. (G'd Cn.)	41	−15	19.0	.....	.....
Yellowstone Pk. (Lake)	43	−8	24.4	4.80	48.0
Yellowstone Pk. (Norris)	48	−15	25.4	.....	.....
Yellowstone Pk (Riv'side)	41	−16	24.9	1.03	14.5
Yellowstone Pk (Snake R)	41	−22	20.8	2.28	23.0
Yellowstone Pk (Soda B)	46	−15	25.8	1.68	19.5
Yellowstone Pk. (Thumb)	44	−13	23.8	1.32	29.0
Porto Rico.					
Adjuntas	79	60	70.0	8.16	
Aguirre	95	62	77.0	1.03	
Albonita	80	54	66.2	7.37	
Alto de La Bandera	81	64	71.8	8.89	
Anasco	87	59	73.6	1.05	
Arecibo	83[c]	54[c]	70.4[c]	16.09	
Barros	88	54	69.2	20.17	
Bayamon	83	58	72.6	15.32	
Caguas	84	57	71.0	11.56	
Canovanas	82	65	74.8	15.88	
Cayey	82	54	68.8	8.94	
Cidra	81	52	68.4	.....	
Corozal	92[i]	55[i]	77.2[i]	7.92	
Fajardo	89	66	77.6	7.65	
Guanica	90	53	73.2	0.25	
Hacienda Colosa	95	55	72.8	3.21	
Hacienda Josefa	.....	.....	.....	0.26	
Humacao	83	58	72.9	6.00	
Isabel	89	63	75.7	9.76	
Isolina	79	57	66.7	21.53	
Juana Diaz	94	65	80.0	3.98	
La Carmelita	83	59	70.3	3.50	
Lares	82	56	71.0	11.94	
Las Marias	82	59	70.6	3.80	
Manati	87	60	73.4	22.62	
Maunabo	87	64	76.6	5.40	
Mayaguez	87	59	74.4	1.49	
Morovis	87	53	70.4	18.53	
Porto Rico—Cont'd.	°	°	°	*Ins.*	*Ins.*
Ponce	91	59	76.1	1.05	
Rio Piedras	.....	.....	.....	13.36	
San Lorenzo	87	54	70.8	7.76	
San Salvador	82	55	68.6	10.03	
Santa Isabel	88[d]	60[d]	74.8[d]	0.84	
Vieques	86	68	76.0	3.03	
Yabucoa	.....	.....	.....	5.08	
Yauco	90	55	73.7	0.53	
New Brunswick.					
St. John	46	−9	21.8	5.57	20.1
Nicaragua.					
Bluefields	86	64	76.8	15.85	

Late reports for November, 1906.

Stations.	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Alaska.					
Central	.....	.....	.....	0.80	8.0
Copper Center	44	−21	8.8	0.99	8.5
Fairbanks	37	−50	00.0	0.65	6.5
Fort Egbert	40	−48	-00.1	.....	.....
Fort Liscum	46	8	29.2	7.50	57.5
Juneau	54	25	40.8	12.27	7.0
Kenai	46	−16	22.8	0.39	7.8
Orca	46	21	33.8	17.08	3.0
Sitka	51	25	40.1	15.59	T.
Sunrise	42	3	24.2	3.87	15.0
Wood Island	48	20	36.0	5.10	T.
Arizona.					
Cochise	.....	.....	.....	0.50	5.0
Kingman	83	16	49.0	1.50	5.0
Pinto	.....	.....	.....	2.15	4.0
Silverbelle	85	34	61.0	0.57	
Tombstone	78	19	53.0	0.34	
California.					
Hanford	.....	.....	.....	0.12	
Laytonville	.....	.....	.....	3.73	1.5
Mendota	78	31	52.7	0.51	
San Miguel	.....	.....	.....	0.66	
Colorado.					
Cascade	.....	.....	.....	4.77	44.2
Fort Collins	.....	.....	.....	1.35	12.5
Gladstone	.....	.....	.....	3.07	38.4
Power House	64	0	36.8	3.39	17.2
Terminal Dam	.....	.....	.....	2.37	
Florida.					
Flamingo	87	45	74.0	.....	.....
Kansas.					
Lawrence	74	15	41.3	3.51	10.0
Oberlin	.....	.....	.....	0.55	3.0
Kentucky.					
Lynnville	82	24	48.7	11.72	3.5
Minnesota.					
Taylors Falls	53	10	34.2	1.78	2.6
Missouri.					
Boonville	.....	.....	.....	2.52	10.6
Seymour	72	16	42.2	2.30	
Montana.					
Lawrenceville	60	15	37.7	1.25	T.
Washington.					
Stehekin	52	21	37.0	10.92	T.
Porto Rico.					
Corozal	92	55	77.0	4.12	
Hacienda Colosa	102	60	79.0	2.56	
Morovis	93	56	74.8	9.28	
Ponce	92[g]	68[g]	80.2[g]	.....	

CORRECTIONS.

November, 1906, California, Napa, make maximum temperature 81°.

Colorado, Rangely, make minimum temperature −7°, and mean temperature 33.5°.

Iowa, Lenox, make mean temperature 36.8°, and Sigourney, mean temperature 37.0°.

Pennsylvania, Somerset, make mean temperature 38.1°.

South Carolina, Clemson College, make mean temperature 51.4°, and Trial, make mean temperature 55.1°.

October, 1906, Florida, Eustis, make maximum temperature 93° and mean temperature 72.7°.

Iowa, Newton, make precipitation 1.51.

Kansas, Eskridge, make mean temperature 55.5°.

Louisiana, Shriever, make precipitation 3.11.

Tennessee, Rugby, make mean temperature 54.1°.

Under late reports for September, 1906, in the October Review, Kentucky, West Liberty, cut out precipitation; Porto Rico, Morovis, make precipitation 11.95; South Dakota, Spearfish, cut out minimum and mean temperature in September and same values for July published late in the August Review.

TABLE III.—*Wind resultants, from observations at 8 a. m. and 8 p. m., daily, during the month of December, 1906.*

Stations.	Component direction from—				Resultant.	
	N.	S.	E.	W.	Direction from—	Duration.
New England.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	°	*Hours.*
Eastport, Me	27	8	7	32	n. 53 w.	31
Portland, Me	33	8	3	30	n. 47 w.	37
Concord, N. H. †	17	6	4	12	n. 36 w.	14
Burlington, Vt. †	11	10	6	9	n. 72 w.	3
Northfield, Vt	28	24	5	15	n. 68 w.	11
Boston, Mass	21	10	9	35	n. 67 w.	28
Nantucket, Mass	26	13	11	28	n. 52 w.	22
Block Island, R. I	26	12	13	27	n. 45 w.	20
Providence, R. I	25	6	8	36	n. 56 w.	34
Hartford, Conn	33	14	7	19	n. 32 w.	22
New Haven, Conn	31	11	11	26	n. 37 w.	25
Middle Atlantic States.						
Albany, N. Y	32	16	11	19	n. 27 w.	18
Binghamton, N. Y. †	13	3	11	9	n. 11 e.	10
New York, N. Y	23	13	12	28	n. 58 w.	19
Harrisburg, Pa	24	13	17	22	n. 24 w.	12
Philadelphia, Pa	30	14	11	26	n. 43 w.	22
Scranton, Pa	22	20	13	24	n. 80 w.	11
Atlantic City, N. J	24	14	10	31	n. 65 w.	23
Cape May, N. J	25	19	11	22	n. 61 w.	12
Baltimore, Md	29	11	11	26	n. 40 w.	23
Washington, D. C	31	12	9	22	n. 34 w.	23
Lynchburg, Va	21	17	17	26	n. 66 w.	10
Mount Weather, Va	26	16	11	28	n. 60 w.	20
Norfolk, Va	20	26	8	19	s. 61 w.	12
Richmond, Va	23	27	9	15	s. 56 w.	7
Wytheville, Va	16	12	6	44	n. 84 w.	38
South Atlantic States.						
Asheville, N. C	26	21	14	16	n. 22 w.	5
Charlotte, N. C	16	27	7	24	s. 57 w.	20
Hatteras, N. C	29	13	5	32	n. 59 w.	31
Raleigh, N. C	18	25	3	27	s. 74 w.	25
Wilmington, N. C	24	18	7	31	n. 76 w.	25
Charleston, S. C	20	15	12	25	n. 69 w.	14
Columbia, S. C	20	24	14	22	s. 63 w.	9
Augusta, Ga	19	19	14	25	w.	11
Savannah, Ga	21	17	11	26	n. 75 w.	16
Jacksonville, Fla	23	20	16	19	n. 45 w.	4
Florida Peninsula.						
Jupiter, Fla	23	19	17	18	n. 14 w.	4
Key West, Fla	33	4	35	4	n. 47 e.	42
Tampa, Fla	30	9	23	14	n. 23 e.	23
Eastern Gulf States.						
Atlanta, Ga	13	20	17	24	s. 45 w.	10
Macon, Ga. †	12	13	7	10	s. 72 w.	3
Thomasville, Ga	18	21	18	17	s. 18 e.	3
Pensacola, Fla. †	14	5	9	8	n. 6 e.	9
Anniston, Ala	22	25	16	13	s. 45 e.	4
Birmingham, Ala	21	22	17	14	s. 72 e.	3
Mobile, Ala	26	17	17	17	n.	9
Montgomery, Ala	16	22	21	16	s. 40 e.	8
Meridian, Miss	21	22	12	19	s. 82 w.	7
Vicksburg, Miss	18	19	21	14	s. 82 e.	7
New Orleans, La	24	19	21	11	n. 63 e.	11
Western Gulf States.						
Shreveport, La	17	24	22	14	s. 49 e.	11
Bentonville, Ark. †	8	14	9	6	s. 27 e.	7
Fort Smith, Ark	14	5	31	17	n. 57 e.	17
Little Rock, Ark	21	20	18	16	n. 63 e.	2
Corpus Christi, Tex	20	25	20	8	s. 67 e.	13
Fort Worth, Tex	23	25	7	18	s. 80 w.	11
Galveston, Tex	17	21	24	12	s. 72 e.	13
Palestine, Tex	20	25	16	16	s.	5
San Antonio, Tex	19	25	26	8	s. 72 e.	19
Taylor, Tex. †	10	13	6	8	s. 34 w.	4
Ohio Valley and Tennessee.						
Chattanooga, Tenn	21	26	16	16	s.	5
Knoxville, Tenn	25	14	15	25	n. 42 w.	15
Memphis, Tenn	21	24	21	11	s. 73 e.	10
Nashville, Tenn	17	21	17	19	s. 27 w.	4
Lexington, Ky. †	9	12	9	10	s. 18 w.	3
Louisville, Ky	17	25	11	21	s. 51 w.	13
Evansville, Ind. †	10	10	9	10	w.	1
Indianapolis, Ind	18	25	15	18	s. 23 w.	8
Cincinnati, Ohio	16	21	18	27	s. 61 w.	10
Columbus, Ohio	16	22	12	26	s. 67 w.	15
Pittsburg, Pa	21	19	8	30	n. 85 w.	22
Parkersburg, W. Va	19	24	11	23	s. 67 w.	13
Elkins, W. Va	19	19	3	30	w.	27
Lower Lake Region.						
Buffalo, N. Y	24	13	15	21	n. 29 w.	12
Canton, N. Y †	8	10	7	13	s. 72 w.	6
Oswego, N. Y	21	23	18	14	s. 63 e.	4
Rochester, N. Y	18	17	10	29	n. 87 w.	19
Syracuse, N. Y	18	15	17	24	n. 67 w.	8
Erie, Pa	21	19	10	24	n. 82 w.	14
Cleveland, Ohio	15	27	12	20	s. 34 w.	14
Sandusky, Ohio †	7	11	4	15	s. 70 w.	12
Toledo, Ohio	20	20	10	28	w.	18
Detroit, Mich	22	17	14	22	n. 58 w.	9
Upper Lake Region.						
Alpena, Mich	21	17	12	28	n. 76 w.	16
Escanaba, Mich	28	16	12	24	n. 45 w.	17
Grand Haven, Mich	25	15	20	14	n. 31 e.	12
Grand Rapids, Mich	21	20	19	14	n. 79 e.	5
Houghton, Mich. †	9	5	13	10	n. 37 e.	5
Marquette, Mich	18	23	11	25	s. 70 w.	15
Port Huron, Mich	20	23	11	24	s. 77 w.	13
Sault Ste. Marie, Mich	21	15	27	17	n. 59 e.	12
Chicago, Ill	20	19	8	34	n. 88 w.	26
Milwaukee, Wis	27	14	8	27	n. 56 w.	23
Green Bay, Wis	24	22	8	23	n. 82 w.	15
Duluth, Minn	20	17	10	30	n. 81 w.	20

Stations.	Component direction from—				Resultant.	
	N.	S.	E.	W.	Direction from—	Duration.
North Dakota.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	°	*Hours.*
Moorhead, Minn	30	23	12	9	n. 23 e.	8
Bismarck, N. Dak	25	13	22	16	n. 27 e.	13
Devils Lake, N. Dak	22	21	15	20	n. 79 w.	5
Williston, N. Dak	25	20	14	16	n. 22 w.	5
Upper Mississippi Valley.						
Minneapolis, Minn. *	10	9	10	13	n. 72 w.	3
Madison, Wis	18	21	14	23	s. 72 w.	10
Charles City, Iowa	20	23	15	16	s. 18 w.	3
St. Paul, Minn	23	22	14	17	n. 72 w.	3
La Crosse, Wis. †	14	12	5	7	n. 45 w.	3
Davenport, Iowa	20	20	17	20	w.	3
Des Moines, Iowa	19	24	12	22	s. 63 w.	11
Dubuque, Iowa	22	21	14	18	n. 76 w.	4
Keokuk, Iowa	20	22	11	24	s. 81 w.	13
Cairo, Ill	23	24	14	15	s. 45 w.	1
La Salle, Ill. †	8	8	5	14	w.	9
Peoria, Ill	17	26	12	19	s. 38 w.	11
Springfield, Ill	20	23	13	20	s. 67 w.	8
Hannibal, Mo. †	9	11	6	13	s. 74 w.	7
St. Louis, Mo	19	29	15	12	s. 17 e.	10
Missouri Valley.						
Columbia, Mo. *	10	8	9	9	n.	2
Kansas City, Mo	21	22	19	20	s. 45 w.	1
Springfield, Mo	23	24	19	13	s. 80 e.	6
Iola, Kans. †	15	11	8	6	n. 27 e.	4
Topeka, Kans. *	12	11	6	8	n. 63 w.	2
Lincoln, Nebr	27	24	17	8	n. 72 e.	10
Omaha, Nebr	24	25	11	15	s. 76 w.	4
Valentine, Nebr	25	16	8	27	n. 65 w.	21
Sioux City, Iowa †	12	13	7	9	s. 63 w.	2
Pierre, S. Dak	20	15	23	19	n. 39 e.	6
Huron, S. Dak	29	16	17	14	n. 13 e.	13
Yankton, S. Dak. †	10	8	8	13	n. 68 w.	5
Northern Slope.						
Havre, Mont	16	11	20	30	n. 63 w.	11
Miles City, Mont	22	23	15	14	s. 45 e.	1
Helena, Mont	20	15	5	39	n. 82 w.	34
Kalispell, Mont	24	12	2	42	n. 73 w.	42
Rapid City, S. Dak	18	9	17	25	n. 42 w.	12
Cheyenne, Wyo	21	15	2	41	n. 81 w.	40
Lander, Wyo	19	17	22	16	n. 72 e.	6
Yellowstone Park, Wyo	4	49	4	19	s. 18 w.	47
North Platte, Nebr	18	19	16	21	s. 79 w.	5
Middle Slope.						
Denver, Colo	20	27	5	18	s. 62 w.	15
Pueblo, Colo	28	8	19	25	n. 17 w.	21
Concordia, Kans	19	28	16	12	s. 24 e.	10
Dodge, Kans	23	22	13	17	n. 76 w.	4
Wichita, Kans	24	26	12	10	s. 45 e.	3
Oklahoma, Okla	25	27	9	10	s. 27 w.	2
Southern Slope.						
Abilene, Tex	18	30	5	18	s. 47 w.	18
Amarillo, Tex	14	32	13	16	s. 9 w.	18
Del Rio, Tex †	7	10	14	10	s. 53 e.	5
Roswell, N. Mex	23	27	6	18	s. 72 w.	13
Southern Plateau.						
El Paso, Tex	24	7	19	28	n. 28 w.	19
Santa Fe, N. Mex	36	7	30	8	n. 37 e.	36
Flagstaff, Ariz	20	14	15	24	n. 56 w.	11
Phoenix, Ariz	19	9	25	20	n. 27 e.	11
Yuma, Ariz	34	4	16	13	n. 6 e.	30
Independence, Cal	21	24	6	24	s. 81 w.	18
Middle Plateau.						
Reno, Nev	12	24	17	24	s. 30 w.	14
Tonopah, Nev	6	27	22	25	s. 8 w.	21
Winnemucca, Nev	21	12	22	24	n. 13 w.	9
Modena, Utah	8	15	17	34	s. 68 w.	18
Salt Lake City, Utah	12	30	26	14	s. 34 e.	22
Durango, Colo	29	13	7	29	n. 54 w.	27
Grand Junction, Colo	16	18	20	21	s. 27 w.	2
Northern Plateau.						
Baker City, Oreg	10	36	16	14	s. 4 e.	26
Boise, Idaho	13	21	24	17	s. 41 e.	11
Lewiston, Idaho †	3	11	17	5	s. 56 e.	14
Pocatello, Idaho	7	30	22	21	s. 2 e.	23
Spokane, Wash	24	17	23	12	n. 58 e.	13
Walla Walla, Wash	13	33	9	16	s. 19 w.	21
North Pacific Coast Region.						
North Head, Wash	13	21	32	7	s. 72 e.	26
Port Crescent, Wash. *	2	13	18	4	s. 52 e.	18
Seattle, Wash	16	23	26	4	s. 72 e.	23
Tacoma, Wash	13	36	11	19	s. 19 w.	24
Tatoosh Island, Wash	2	22	32	12	s. 45 e.	28
Portland, Oreg	19	25	16	17	s. 9 w.	6
Roseburg, Oreg	10	23	23	19	s. 17 e.	14
Middle Pacific Coast Region.						
Eureka, Cal	11	29	23	16	s. 21 e.	19
Mount Tamalpais, Cal	24	19	14	18	n. 39 w.	6
Red Bluff, Cal	28	17	14	21	n. 32 w.	13
Sacramento, Cal	18	28	26	5	s. 65 e.	23
San Francisco, Cal	19	22	11	24	s. 77 w.	13
San Jose, Cal. †	12	9	7	14	n. 67 w.	8
Southeast Farallon, Cal. *	12	10	7	8	n. 27 w.	2
South Pacific Coast Region.						
Fresno, Cal	20	16	23	18	n. 51 e.	6
Los Angeles, Cal	20	8	27	20	n. 30 e.	14
San Diego, Cal	29	8	24	18	n. 16 e.	22
San Luis Obispo, Cal	38	10	15	16	n. 2 w.	28
West Indies						
San Juan, Porto Rico	25	8	38	1	n. 66 e.	41
Grand Turk, W. I. †	13	3	21	2	n. 62 e.	22

* From observations at 8 p. m. only. † From observations at 8 a. m. only.

TABLE IV.—*Accumulated amounts of precipitation for each 5 minutes, for storms in which the rate of fall equaled or exceeded 0.25 in any 5 minutes, or 0.75 in 1 hour, during December, 1906, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Abilene, Tex	15–16			0.31														0.08			
Albany, N. Y	31			0.64														*			
Alpena, Mich	5–6			1.30														*			
Amarillo, Tex	1			0.19														*			
Anniston, Ala	29–30	D. N.	6:10 p. m.	1.88	4:48 p. m.	5:13 p. m.	1.32	0.10	0.19	0.33	0.45	0.51									
Asheville, N. C	17			0.39														0.20			
Atlanta, Ga	29–31			1.32									0.36								
Atlantic City, N. J	10–11			0.88														0.22			
Augusta, Ga	19–20			0.94														*			
Baltimore, Md	31			1.05														0.26			
Bentonville, Ark	14			0.61														0.27			
Binghamton, N. Y	5–6			0.57														*			
Birmingham, Ala	29–30			1.55														0.62			
Bismarck, N. Dak	13–14			0.37														*			
Block Island, R. I	31			1.21														0.40			
Boise, Idaho	7–9			0.57														*			
Boston, Mass	31			1.68														0.42			
Buffalo, N. Y	5–6			1.19														*			
Cairo, Ill	29–30			2.75														0.55			
Canton, N. Y	14–15			0.83														*			
Charles City, Iowa	29–30			0.66														*			
Charleston, S. C	18–20			1.37														0.27			
Charlotte, N. C	10			1.46														0.37			
Chattanooga, Tenn	27–31			2.06														0.40			
Cheyenne, Wyo	4–5			0.15														*			
Chicago, Ill	5–6			1.12														*			
Cincinnati, Ohio	9–10			1.03														*			
Cleveland, Ohio	5–6			1.34														0.26			
Columbia, Mo	29–30			0.75														0.18			
Columbia, S. C	19–20			1.23														0.35			
Columbus, Ohio	14–15			0.81														*			
Concord, N. H	31			1.70														*			
Corpus Christi, Tex	15–16			0.12														0.05			
Davenport, Iowa	29–30			1.18														*			
Del Rio, Tex	18			0.27														0.05			
Denver, Colo	4			0.01														*			
Des Moines, Iowa	29–30			0.95														*			
Detroit, Mich	5–6			1.99														0.31			
Dodge, Kans	1			0.18														*			
Dubuque, Iowa	29–30			1.46														*			
Duluth, Minn	30–31			0.37														*			
Eastport, Me	6–7			1.30														0.17			
Elkins, W. Va	9–10			1.33														0.19			
Erie, Pa	5–6			1.57														0.23			
Escanaba, Mich	30–31			1.22														*			
Evansville, Ind	14–17			2.92														*			
Fort Smith, Ark	14–16			2.16																	0.62
Fort Worth, Tex	14–16			0.99														0.17			
Galveston, Tex	9			0.57														0.53			
Grand Haven, Mich	30–31			0.82														0.14			
Grand Rapids, Mich	30–31			0.84														0.25			
Green Bay, Wis	30–31			0.88														*			
Hannibal, Mo	29–30			0.93														0.20			
Harrisburg, Pa	30–31			1.85														0.23			
Hartford, Conn	30–31			1.54														*			
Hatteras, N. C	19–20			1.43														0.51			
Huron, S. Dak	5			0.53														*			
Indianapolis, Ind	5			1.08														0.21			
Iola, Kans	14			0.07														0.07			
Jacksonville, Fla	18			0.54																	0.28
Jupiter, Fla	21			0.05														0.05			
Kansas City, Mo	29–30			1.35														*			
Key West, Fla	18			0.19														0.10			
Knoxville, Tenn	27–28			1.18														0.12			
La Crosse, Wis	30			1.13														*			
La Salle, Ill	5–6			0.90														0.20			
Lexington, Ky	30			0.73														0.31			
Lincoln, Nebr	29–30			0.82														0.19			
Little Rock, Ark	29–30	3:50 p. m.	5:00 a. m.	1.83	11:55 p. m.	12:50 a. m.	0.31	0.13	0.30	0.42	0.56	0.58	0.59	0.62	0.71	0.80	0.82	0.95			
Los Angeles, Cal	27–28			1.20														0.41			
Louisville, Ky	9–10			1.40														0.25			
Lynchburg, Va	30–31			1.08														0.23			
Macon, Ga	19–20			1.28														0.34			
Madison, Wis	30–31			0.79														0.13			
Marquette, Mich	30–31			1.07														*			
Memphis, Tenn	29–30	8:20 p. m.	8:35 a. m.	1.51	5:41 a. m.	6:00 a. m.	0.89	0.25	0.33	0.40	0.43										
Meridian, Miss	9–10			1.68														0.54			
Milwaukee, Wis	29–30			0.74														0.13			
Minneapolis, Minn	30–31			0.45														*			
Montgomery, Ala	10	7:30 a. m.	9:45 a. m.	0.57	8:28 a. m.	8:40 a. m.	0.04	0.26	0.41	0.45											
Mount Weather, Va	10–11			0.75														0.16			
Nantucket, Mass	20–21			1.57														0.39			
Nashville, Tenn	30			1.69														0.53			
New Haven, Conn	30–31			1.51														0.42			
New Orleans, La	15			1.32														0.47			
New York, N. Y	31			0.96														0.30			
Norfolk, Va	19–20			1.19																	0.56
Northfield, Vt	31			1.20														*			
North Head, Wash	14–16			1.61														0.27			
Oklahoma, Okla	1–2			0.32														0.19			
Omaha, Nebr	29–30			1.08														*			
Palestine, Tex	14–16			5.15														0.75			
Parkersburg, W. Va	9–10			1.08														0.27			
Pensacola, Fla	30	1:05 p. m.	9:15 p. m.	1.44	2:37 p. m.	2:57 p. m.	0.07	0.20	0.38	0.54	0.81										
Peoria, Ill	4–5			0.86														*			
Philadelphia, Pa	30–31			0.65														0.24			
Pittsburg, Pa	5–6			0.62														*			
Portland, Me	31			1.46														0.44			
Portland, Oreg	19–20			1.57														0.20			
Pueblo, Colo	4			T.																	

TABLE IV.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Raleigh, N. C	19-20			1.60														*			
Richmond, Va	31			0.64														0.24			
Rochester, N. Y	3			0.60														*			
Sacramento, Cal	10-11			3.09														0.37			
St. Louis, Mo	14			0.48														0.22			
St. Paul, Minn	30-31			0.60														0.22			
Salt Lake City, Utah	12			0.37														*			
San Antonio, Tex	15-16			0.88														0.29			
San Diego, Cal	26-29			2.10														0.41			
Sandusky, Ohio	5-6			1.35														*			
San Francisco, Cal	9-11			2.96														0.59			
Savannah, Ga	20			0.62														0.32			
Scranton, Pa	30-31			1.15														0.24			
Seattle, Wash	6-7			2.86														0.28			
Shreveport, La	15-16			2.32														0.31			
Spokane, Wash	24-25			0.64														*			
Springfield, Ill	4-5			1.73														0.60			
Springfield, Mo	29			0.44														*			
Syracuse, N. Y	6			0.80														*			
Tampa, Fla	29			0.09														0.08			
Taylor, Tex	14-16			2.03														0.35			
Thomasville, Ga	30-31			0.68														0.35			
Toledo, Ohio	5-6			1.75														*			
Topeka, Kans	29-30			0.34														0.11			
Valentine, Nebr	4-5			0.25														*			
Vicksburg, Miss	30			1.23														0.63			
Washington, D. C	31			0.68														0.20			
Wichita, Kans	‡30-1			1.16														0.16			
Wilmington, N. C	6			0.57														0.48			
Wytheville, Va	27-28			0.37														*			
Yankton, S. Dak	29-31			0.78														*			
San Juan, Porto Rico	24	12:28 p.m.	1:20 p.m.	0.48	12:50 p.m.	1:05 p.m.	0.02	0.23	0.33	0.45											

*Self-register not working † Partly estimated. ‡ November.

TABLE V.—*Data furnished by the Canadian Meteorological Service, December, 1906.*

Stations.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Pressure, in inches. Sea level, reduced to mean of 24 hours.	Pressure, in inches. Departure from normal.	Temperature. Mean.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Total snowfall.
	Ins.	Ins.	Ins.	°	°	°	°	Ins.	Ins.	Ins.
St. Johns, N. F	29.87	30.01	+.18	29.3	+ 0.6	35.1	23.5	3.71	−1.32	4.0
Sydney, C. B. I	29.99	30.03	+.14	28.7	+ 0.5	36.4	21.1	12.25	+7.62	16.5
Halifax, N. S	29.93	30.04	+.08	28.0	+ 0.4	35.9	20.1	9.96	+4.84	15.6
Grand Manan, N. B	29.95	30.00	+.02	26.6	− 1.7	34.8	18.4	5.01	+0.59	13.9
Yarmouth, N. S	29.96	30.03	+.05	29.2	− 1.5	36.6	21.8	6.87	+1.83	19.9
Charlottetown, P. E. I	29.96	30.00	+.06	23.6	− 0.7	30.0	17.3	7.25	+3.59	34.2
Chatham, N. B	29.98	30.01	+.07	17.3	+ 3.3	26.4	8.2	3.43	+0.21	26.4
Father Point, Que	30.02	30.05	+.10	13.9	− 1.5	20.9	7.0	2.81	−0.02	26.2
Quebec, Que	29.75	30.10	+.09	12.0	− 3.2	18.6	5.3	3.24	−0.45	30.9
Montreal, Que										
Rockliffe, Ont	29.53	30.17	+.16	7.1	− 7.9	17.4	− 3.3	1.75	−0.74	15.9
Ottawa, Ont	29.77	30.12	+.10	12.5	− 4.5	19.4	5.6	2.59	−0.32	17.5
Kingston, Ont	29.83	30.17	+.13	18.3	− 5.4	26.6	10.1	2.09	−1.15	14.6
Toronto, Ont	29.75	30.15	+.10	23.3	− 3.7	30.8	15.7	2.82	−0.09	12.8
White River, Ont										
Port Stanley, Ont	29.49	30.15	+.08	26.8	− 1.6	33.7	20.0	3.64	+1.22	11.3
Saugeen, Ont	29.41	30.15	+.13	24.1	− 2.6	31.6	16.6	3.37	−0.61	16.8
Parry Sound, Ont	29.42	30.16	+.15	15.3	− 5.9	25.4	5.2	3.94	−0.54	26.5
Port Arthur, Ont	29.46	30.21	+.22	12.9	− 0.3	22.6	3.3	0.55	−0.32	5.5
Winnipeg, Man	29.34	30.24	+.22	2.0	− 2.1	11.8	− 7.8	1.26	+0.35	12.6
Minnedosa, Man	28.27	30.21	+.19	3.0	− 2.7	13.4	− 7.4	1.23	+0.61	12.3
Qu'Appelle, Sask	27.75	30.12	+.12	5.5	− 1.9	15.6	− 4.6	0.85	+0.33	8.5
Medicine Hat, Alberta	27.69	30.07	+.10	15.0	− 3.2	24.0	5.9	0.95	+0.40	9.5
Swift Current, Sask	27.42	30.14	+.15	11.8	− 4.2	20.4	3.2	1.16	+0.38	10.6
Calgary, Alberta	26.37	30.10	+.16	11.6	− 6.6	20.6	2.6	0.25	−0.34	2.5
Banff, Alberta	25.29	30.10	+.16	15.4	− 3.7	24.8	5.9	1.50	+0.29	14.9
Edmonton, Alberta	27.69	30.13	+.20	3.9	− 9.2	13.1	− 5.3	1.97	+1.27	19.7
Prince Albert, Sask	28.48	30.15	+.14	−1.0	− 3.8	9.5	−11.6	2.61	+1.87	26.1
Battleford, Sask	28.30	30.16	+.17	1.1	− 4.3	9.9	− 7.7	1.46	+1.14	14.6
Kamloops, B. C	28.70	29.94	.00	30.1	+ 1.2	34.7	25.5	2.04	+1.26	20.2
Victoria, B. C	29.88	29.98	+.01	41.2	0	45.1	37.4	3.85	−4.13	0.3
Barkerville, B. C	25.50	29.91	+.03	19.0	− 1.9	25.5	12.4	5.86	+2.69	53.0
Hamilton, Bermuda	30.00	30.17	+.05	63.1	− 1.6	67.9	58.2	5.34	+0.85	
Dawson, Yukon										

TABLE VI.—*Heights of rivers referred to zeros of gages, December, 1906.*

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Milk River.								
Havre, Mont. (31)	237	9						
James River.								
Huron, S. Dak. (31)	139	9						
Republican River.								
Clay Center, Kans	42	18	6.4	30, 31	5.5	18-21	5.9	0.9
Smoky Hill-Kansas River.								
Abilene, Kans	277	22	1.0	18-20	0.2	26, 30	0.6	0.8
Kansas River.								
Manhattan, Kans. (6)	116	18	3.3	3-6, 10, 11, 30, 31	3.1	17, 18, 25-27	3.2	0.2
Topeka, Kans	87	21	6.5	1	5.9	23-27	6.1	0.6
Missouri River.								
Bismarck, N. Dak	1,309	14	2.6	16	0.9	30	1.9	1.7
Pierre, S. Dak. (18)	1,114	14	0.4	13	−1.5	4, 5, 7		1.9
Sioux City, Iowa	784	17	7.4	29	3.8	10	5.4	3.6
Blair, Nebr	705	15	8.2	31	2.7	9	5.0	5.5
Omaha, Nebr. (18)	669	18	5.6	7, 8	3.2	13	4.4	2.4
St. Joseph, Mo	481	10	1.0	6, 9, 10	−2.3	19	−0.2	3.3
Missouri River—Cont'd.								
Kansas City, Mo	388	21	7.2	7-10	2.3	26	5.2	4.9
Glasgow, Mo	231	18	5.0	11	2.2	28	3.9	2.8
Boonville, Mo	199	20	9.4	9	7.1	27-29	8.4	2.3
Hermann, Mo	103	24	8.0	4, 6, 7	4.8	29, 30	6.5	3.2
Minnesota River.								
Mankato, Minn	127	18	6.0	9, 10, 12-14	3.6	28-31	4.6	2.4
St. Croix River.								
Stillwater, Minn. (31)	23	11						
Red Cedar River.								
Cedar Rapids, Iowa	77	14	4.7	16, 22	3.2	8	4.0	1.5
Des Moines River.								
Des Moines, Iowa	205	19	3.9	1	2.5	27-31	3.3	1.4
Illinois River.								
La Salle, Ill	197	18	17.4	9-11	14.1	5	16.3	3.3
Peoria, Ill	135	14	12.6	17, 18	10.7	2	11.7	1.9
Clarion River.								
Clarion, Pa	32	10	7.0	7	1.8	2, 3, 30	3.1	5.2

TABLE VI.—*Heights of rivers referred to zeros of gages*—Continued.

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Conemaugh River.								
Johnstown, Pa.	64	7	5.8	11	1.2	3-5	2.8	4.6
Allegheny River								
Warren, Pa	177	14	7.4	7	1.5	30, 31	3.4	5.9
Franklin, Pa	114	15	9.3	7	1.5	27	4.4	7.8
Parker, Pa.	73	20	8.5	8	1.8	27, 28	4.4	6.7
Freeport, Pa.	29	20	14.6	8	4.4	5	8.4	10.2
Springdale, Pa.	17	27	18.6	8	8.1	27	11.7	10.5
Cheat River.								
Rowlesburg, W. Va. (3)	36	14	8.0	11	2.1	5, 6	3.9	5.9
Youghiogheny River.								
Confluence, Pa.	59	10	8.2	11	0.2	1	2.8	8.0
West Newton, Pa.	15	23	11.6	11	1.0	1, 27	3.7	10.6
Monongahela River.								
Weston, W. Va.	161	18	9.0	17	− 0.4	1	2.0	9.4
Fairmont, W. Va.	119	25	23.3	11	14.8	1, 2	17.0	8.5
Greensboro, Pa	81	18	18.9	17	7.6	1	10.4	11.3
Lock No. 4, Pa.	40	28	23.0	12	7.1	1, 2	12.1	15.9
Beaver River.								
Ellwood Junction, Pa. (3)	10	14	5.4	7	1.8	25, 29	2.6	3.6
Muskingum River.								
Zanesville, Ohio	70	25	15.0	16	8.8	5	11.3	6.2
Beverly, Ohio.	20	25	12.9	17	6.4	5	9.0	6.5
Little Kanawha River.								
Glenville, W. Va	77	20	14.6	18	1.6	1, 4, 15	3.7	13.0
Creston, W. Va.	38	20	18.5	18	3.0	1, 2	5.8	15.5
New-Great Kanawha River.								
Radford, Va	213	14	4.2	23	1.0	3, 4	2.5	3.2
Hinton, W. Va.	153	14	6.5	18	2.0	27	3.1	4.5
Charleston, W. Va.	58	30	17.2	18	4.5	17	7.5	12.7
Scioto River.								
Columbus, Ohio. (4)	110	17	7.6	31	3.4	3	4.3	4.2
Licking River.								
Falmouth, Ky.	30	25	18.4	18	1.5	9	5.9	16.9
Miami River.								
Dayton, Ohio. (3)	77	18	4.1	16	2.2	4, 5	2.7	1.9
Kentucky River.								
Jackson, Ky.	287	24	16.5	18	4.4	16	6.6	12.1
Beattyville, Ky	254	30	19.3	18	0.4	1-5, 7-9	3.5	18.9
High Bridge, Ky.	117	17	18.9	19	9.0	1	12.1	9.9
Frankfort, Ky.	65	31	17.2	18	5.9	6-9	8.6	11.3
Wabash River.								
Terre Haute, Ind.	171	16	11.3	9	2.4	4, 5	6.3	8.9
Mount Carmel, Ill.	75	15	15.5	20	4.5	6	9.5	11.0
Cumberland River.								
Burnside, Ky.	518	50	32.2	18	1.7	6	8.5	30.5
Celina, Tenn.	383	45	30.6	31	3.8	5, 6	11.0	26.8
Carthage, Tenn.	308	40	26.0	21	3.3	6	9.8	22.7
Nashville, Tenn.	193	40	29.3	22	9.4	6, 11-13	15.3	19.9
Clarksville, Tenn.	126	42	36.8	23, 24	7.3	9	17.7	29.5
Powell River.								
Tazewell, Tenn.	44	20	8.0	30	0.9	8-10, 13-16	2.1	7.1
Clinch River.								
Speers Ferry, Va.	156	20	8.3	29	0.1	10	1.6	8.2
Clinton, Tenn	52	25	18.0	31	4.7	12, 13	7.2	13.3
South Fork Holston River.								
Bluff City, Tenn.	35	15	5.5	29	1.1	6, 9, 10, 15-17	1.8	4.4
Holston River.								
Mendota, Va	165	8	6.6	29	1.0	9-11	1.9	5.6
Rogersville, Tenn.	103	14	6.8	29, 30	2.2	10, 11, 16, 17	3.0	4.6
French Broad River.								
Asheville, N. C.	144	6	1.6	11, 31	0.4	6-10, 27-30	0.7	1.2
Dandridge, Tenn. (2)	46	12	6.9	29	1.7	6, 10, 17	2.4	5.2
Little Tennessee River.								
McGhee, Tenn.	17	20	7.8	18	3.9	26	4.9	3.9
Hiwassee River.								
Charleston, Tenn	18	22	9.5	31	3.0	10, 17, 26, 27	4.1	6.5
Tennessee River.								
Knoxville, Tenn.	635	12	10.9	30	2.1	27	3.6	8.8
Loudon, Tenn.	590	25	10.0	31	2.7	10, 12-17	3.7	7.3
Kingston, Tenn.	556	25	12.0	31	3.0	8-10, 12-17	4.4	9.0
Chattanooga, Tenn.	452	33	16.3	31	5.1	17	6.8	11.2
Bridgeport, Ala	402	24	11.8	31	3.6	6, 7	5.0	8.2
Guntersville, Ala.	349	31	11.5	31	6.0	9, 10	7.9	5.5
Florence, Ala.	255	16	7.3	23	3.5	9	5.0	3.8
Riverton, Ala.	225	26	11.9	23	6.2	9	8.3	5.7
Johnsonville, Tenn.	95	21	15.3	1	6.0	11	9.4	9.3
Ohio River.								
Pittsburg, Pa.	966	22	17.4	12	2.8	27	8.1	14.6
Dam No. 2, Pa.	956	25	16.8	12	3.6	3	8.3	13.2
Beaver Dam, Pa	925	27	23.0	12	6.0	3	12.5	17.0
Wheeling, W. Va.	875	36	22.9	13	6.0	3, 4	12.3	16.9
Parkersburg, W. Va.	785	36	21.1	14	7.2	5, 6	13.2	13.9
Point Pleasant, W. Va.	703	39	30.3	19	5.5	6	15.9	24.8
Huntington, W. Va	660	50	35.5	19	8.8	6	19.8	26.7
Catlettsburg, Ky.	651	50	36.5	19	7.7	6, 7	19.9	28.8
Portsmouth, Ohio	612	50	36.8	20	8.5	7	20.9	28.3
Maysville, Ky.	559	50	36.4	20	8.7	8	20.6	27.7
Cincinnati, Ohio.	499	50	39.1	20	11.0	9	23.3	28.1
Madison, Ind	413	46	33.3	21	10.0	9	20.2	23.3
Louisville, Ky.	367	28	15.1	21	4.8	9, 10	8.7	10.3
Evansville, Ind.	184	35	34.7	23	9.3	10	22.1	25.4
Mount Vernon, Ind	148	35	33.7	24	9.5	10	21.7	24.2
Paducah, Ky.	47	40	30.9	24, 25	11.7	10	22.0	19.2
Cairo, Ill.	1	45	33.9	1, 25	19.8	10	27.4	14.1
St. Francis River.								
Marked Tree, Ark.	104	17	17.8	18-20	16.2	4-8	17.0	1.6
Neosho River.								
Neosho Rapids, Kans.	326	22	1.8	4	1.0	21-31	1.2	0.8
Iola, Kans.	262	10	3.4	2	0.1	26	0.6	3.3
Oswego, Kans.	184	20	9.9	3	0.4	27-30	1.5	9.5
Fort Gibson, Ind. T	3	22	13.6	6	8.6	28-31	9.9	5.0

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Canadian River.								
Calvin, Ind. T	99	10	4.4	5, 6	2.8	25, 26	3.3	1.6
Black River.								
Blackrock, Ark.	67	12	21.9	16	11.6	14	16.4	10.3
White River.								
Calicorock, Ark	272	15	12.2	16	2.9	1	5.1	9.3
Batesville, Ark.	217	18	16.5	17	4.9	2	7.9	11.6
Newport, Ark.	185	26	23.4	19, 20	12.7	14, 15	17.4	10.7
Clarendon, Ark.	75	30	28.6	31	25.6	14, 15	26.8	3.0
Arkansas River.								
Wichita, Kans.	832	10	(b) 2.7	18	0.3	27-30	0.8	2.4
Tulsa, Ind. T.	551	16	6.6	5	3.6	1	4.3	3.0
Webbers Falls, Ind. T.	465	23	9.0	6	3.0	1	5.8	6.0
Fort Smith, Ark.	403	22	10.0	7	2.0	2	5.7	8.0
Dardanelle, Ark.	256	21	9.7	16	2.4	3	5.9	7.3
Little Rock, Ark.	176	23	13.5	17	4.0	6	8.2	9.5
Pine Bluff, Ark.	121	23	16.0	19	5.8	5-7	10.5	10.2
Yazoo River.								
Greenwood, Miss	175		32.6	14	25.7	1	30.6	6.9
Yazoo City, Miss.	80	25	22.3	31	17.2	1	20.2	5.1
Ouachita River.								
Camden, Ark.	304	39	35.0	22	6.0	10	16.3	29.0
Monroe, La	122	40	29.0	31	20.0	12-15	23.0	9.0
Red River								
Denison, Tex.	768	22	5.2	4	1.2	3	2.8	4.0
Arthur City, Tex.	688	27	11.4	7	6.6	3	8.9	4.8
Fulton, Ark.	515	28	21.1	21	8.3	5, 6	13.5	12.8
Shreveport, La.	327	29	12.8	22-24	0.9	9	6.4	11.9
Alexandria, La.	118	33	18.2	27	4.6	10	9.8	13.6
Mississippi River.								
Fort Ripley, Minn (20)	2,082	10	8.4	3	......	......	......	......
St. Paul, Minn. (21)	1,954	14	......	......	......	......	......	......
Red Wing, Minn (21)	1,914	14	......	......	......	......	......	......
Reeds Landing, Minn. (28)	1,884	12	......	......	......	......	......	......
La Crosse, Wis. (14)	1,819	12	6.8	17	4.4	12	5.3	2.4
Prairie du Chien, Wis. (21)	1,759	18	7.6	6-10	......	......	......	......
Dubuque, Iowa (13)	1,699	18	7.8	6, 7	4.4	15	6.2	3.4
Clinton, Iowa (19)	1,629	16	7.0	8	......	......	......	......
Leclaire, Iowa (10)	1,609	10	4.6	1, 7, 8	1.3	21	3.2	3.3
Davenport, Iowa	1,593	15	6.4	7	2.0	20	4.2	4.4
Muscatine, Iowa	1,562	16	7.3	1	3.3	21	5.5	4.0
Galland, Iowa	1,472	8	3.8	1	0.4	24	2.4	3.4
Keokuk, Iowa.	1,463	15	5.9	1, 2	0.4	24	3.8	5.5
Warsaw, Ill.	1,458	18	8.7	1	4.8	26	7.0	3.9
Hannibal, Mo	1,402	13	6.8	2	1.0	26	4.8	5.8
Grafton, Ill	1,306	23	9.0	7	4.4	28	7.1	4.6
St. Louis, Mo	1,264	30	10.9	7	3.0	28	7.5	7.9
Chester, Ill	1,189	30	9.5	8, 9	2.6	29	6.9	6.9
Cape Girardeau, Mo.	1,128	28	13.8	9	7.4	29	11.6	6.4
New Madrid, Mo.	1,003	34	28.2	1	16.4	11	22.5	11.8
Luxora, Ark	905	33	24.0	1	9.0	12, 13	16.2	15.0
Memphis, Tenn	843	33	29.2	1	13.5	13, 14	21.1	15.7
Helena, Ark.	767	42	37.3	2	19.8	14, 15	29.4	17.5
Arkansas City, Ark.	635	42	39.1	4, 5	27.1	16, 17	34.4	12.0
Greenville, Miss.	595	42	33.7	5	22.9	17	29.4	10.8
Vicksburg, Miss.	474	45	36.9	6, 7	27.1	19	33.0	9.8
Natchez, Miss.	373	46	36.0	8, 9	28.3	20	33.0	7.7
Baton Rouge, La.	240	35	26.9	31	21.5	23	24.4	5.4
Donaldsonville, La	188	28	21.4	31	17.0	22	19.2	4.4
New Orleans, La.	108	16	14.6	31	11.1	1	12.7	3.5
Atchafalaya River.								
Simmesport, La.	127	33	30.2	11	25.7	21	27.9	4.5
Melville, La.	103	31	30.6	31	27.9	1, 21, 22	29.2	2.7
Morgan City, La	19	8	4.5	22	1.7	25	3.4	2.8
Grand River.								
Grand Rapids, Mich.	38	11	3.2	17	1.8	30	2.4	1.4
Sandusky River.								
Tiffin, Ohio (4)	65	8	4.0	31	0.7	2	1.9	3.3
Penobscot River.								
Mattawamkeag, Me. (29)	87	......	......	......	......	......	......	......
West Enfield, Me. (28)	60	......	......	......	......	......	......	......
Kennebec River.								
Winslow, Me	46	8	5.2	26	2.8	7	4.5	2.4
Merrimac River.								
Franklin Junction, N. H (a)	110	13	5.0	10	4.0	30	4.5	1.0
Concord, N. H. (29)	94	10	......	......	......	......	......	......
Manchester, N. H	68	8	3.7	2	0.8	5	2.2	2.9
Connecticut River.								
Wells River, Vt. (3)	255	34	......	......	......	......	......	......
Whiteriver Junction, Vt (29)	209	......	......	......	......	......	......	......
Bellows Falls, Vt	170	12	3.4	9	1.3	11	1.9	2.1
Holyoke, Mass	84	9	3.9	2	0.2	5	2.0	3.7
Hartford, Conn. (24)	50	16	......	......	......	......	......	......
Housatonic River.								
Gaylordsville, Conn	44	15	4.5	16, 17	3.6	4, 27	4.0	0.9
Mohawk River.								
Utica, N. Y	98	6	8.0	17	1.7	4	3.1	6.3
Tribeshill, N. Y	42	12	3.2	18	1.0	3-8, 29, 30	1.9	2.2
Schenectady, N. Y.	19	15	2.9	6	1.2	1	1.6	1.7
Hudson River.								
Glens Falls, N. Y	197	20	4.3	1	3.4	4, 10-13, 15, 16	3.7	0.9
Troy, N. Y.	154	14	4.5	13	2.5	30	3.7	2.0
Albany, N. Y	147	12	4.9	18	0.5	4	2.8	4.4
Stuvesant, N. Y	128	9	3.0	22	− 1.0	1, 27	1.1	4.0
Pompton River.								
Pompton Plains, N. J (8)	6	8	4.6	20, 21	3.8	3-11	4.0	0.8
Passaic River.								
Chatham, N. J (17)	69	7	4.0	21	2.2	2, 3	......	1.8
Lehigh River.								
Mauch Chunk, Pa (22)	45	15	......	......	......	......	......	......
Schuylkill River.								
Reading, Pa.	66	12	1.5	23	0.2	4, 5, 8, 9	0.7	1.3

TABLE VI.—*Heights of rivers referred to zeros of gages*—Continued.

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Delaware River.								
Hancock (E. Branch), N. Y.	269	12	5.3	7	3.4	24	4.2	1.9
Hancock (W. Branch), N. Y.	269	10	5.5	6, 7	3.0	24	4.2	2.5
Port Jervis, N. Y.	204	14	3.2	8	0.9	4	1.7	2.3
Phillipsburg, N. J. (10)	142	26	3.5	18, 22	.....	.....	.....	.....
Trenton, N. J.	92	18	5.6	31	1.2	12	2.4	4.4
North Branch Susquehanna.								
Binghamton, N. Y.	183	16	6.2	7	2.5	4	3.5	3.7
Towanda, Pa.	139	16	5.4	17	2.2	6, 29	2.0	3.2
Wilkes-Barre, Pa.	60	17	9.9	8	4.8	5, 6	7.0	5.1
West Branch Susquehanna.								
Clearfield, Pa.	165	8	3.5	7	1.1	4, 5	1.8	2.4
Renovo, Pa. (9)	90	16	5.0	8	1.4	2–4	3.0	3.6
Williamsport, Pa.	39	20	5.3	8	1.7	26	3.1	3.6
Juniata River.								
Huntingdon, Pa.	90	24	5.5	31	3.0	1–3, 5, 6	3.7	2.5
Susquehanna River.								
Selinsgrove, Pa.	116	17	4.4	9, 18	1.8	4, 5	2.5	2.6
Harrisburg, Pa.	69	17	4.8	10	2.1	5, 28	3.2	2.7
Shenandoah River.								
Riverton, Va.	58	22	— 0.5	1–17, 19–31	— 0.6	18	—0.5	0.1
Potomac River.								
Cumberland, Md.	290	8	6.5	17	2.9	1, 2	4.5	3.6
Harpers Ferry, W. Va.	172	18	11.0	19	0.7	11	3.5	10.3
James River.								
Buchanan, Va.	305	12	7.3	18	2.6	10	3.6	4.7
Lynchburg, Va.	260	18	5.0	20	0.7	14–16	1.7	4.3
Columbia, Va.	167	18	11.1	19	3.3	15–17	5.3	7.8
Richmond, Va.	111	12	2.8	20	0.2	16	0.9	2.6
Dan River.								
Danville, Va.	55	8	1.6	21	— 0.1	4–6	0.4	1.7
Staunton River.								
Randolph, Va.	26	28	8.9	19	5.2	26, 27	6.1	3.7
Roanoke River.								
Clarksville, Va.	196	12	3.9	20	0 1	3, 7, 8	1.4	3.8
Weldon, N. C.	129	30	17.1	19, 22	10.6	27, 28	11.8	6.5
Tar River.								
Tarboro, N. C.	46	25	8.0	22	2.3	3, 5–10	3.8	5.7
Greenville, N. C.	21	22	8.2	26	3.4	1–3	4.5	4.8
Haw River.								
Moncure, N. C.	171	25	10.3	21	8.2	7–10	8.6	2.1
Cape Fear River.								
Fayetteville, N. C.	112	38	14.5	22	2.8	4–6	5.6	11.7
Waccamaw River.								
Conway, S. C.	40	7	3.4	22	1.4	2, 8	2.3	2.0
Pedee River.								
Cheraw, S. C.	149	27	9.8	22	2.9	5–7	4.3	6.9
Smiths Mills, S. C.	51	16	10.9	28	5.0	10–13	7.8	5.9
Lynch Creek.								
Effingham, S. C.	35	12	7.5	27	3.1	1, 2	5.0	4.4
Black River.								
Kingstree, S. C.	45	12	8.0	30, 31	4.8	10, 11	5.8	3.2
Catawba-Wateree River.								
Mount Holly, N. C.	143	15	2.8	11	1.9	10	2.2	0.9
Catawba, S. C.	107	11	4.0	12	2.3	7	2.9	1.7
Camden, S. C.	37	24	11.9	12	6.2	10	8.1	5.7
Broad River.								
Blairs, S. C.	36	14	3.0	31	0.2	5	1.7	2.8
Saluda River.								
Pelzer, S. C.	109	7	4.6	18, 19	3.3	6, 7	3.7	1.3
Chappels, S. C.	56	14	8.5	20	2.5	6	4.1	6.0
Congaree River.								
Columbia, S. C.	52	15	3.6	21	0.9	2	1.7	2.7
Santee River.								
Rimini, S. C.	108	12	12.2	23	7.7	11	9.4	4.5
St. Stephens, S. C.	50	10	8.2	26	5.8	12, 13	7.2	2.4
Edisto River.								
Edisto, S. C.	75	6	4.7	31	2.2	7	3.3	2.5
Broad River.								
Carlton, Ga.	30	11	4.6	11	2.5	1–6, 9, 10	3.0	2.1
Savannah River.								
Calhoun Falls, S. C.	347	15	4.0	13, 31	2.6	3–6	3.2	1.4
Augusta, Ga.	268	32	13.6	21	8.7	6	10.0	4.9
Oconee River.								
Milledgeville, Ga.	147	25	6.0	21	2.9	1, 2, 5, 6	3.8	3.1
Dublin, Ga.	79	30	5.3	22	0.7	3, 6, 7	2.0	4.6
Ocmulgee River.								
Macon, Ga.	203	18	6.8	31	2.7	2	3.7	4.1
Abbeville, Ga.	96	11	6.4	24	2.8	5	4.0	3.6
Flint River.								
Woodbury, Ga.	227	10	2.2	31	0.6	5, 7	1.0	1.6
Flint River—Cont'd.								
Montezuma, Ga.	152	20	7.6	23	3.5	5, 6	4.5	4.1
Albany, Ga.	90	20	5.0	24, 25	1.7	4–6	2.6	3.3
Bainbridge, Ga.	29	22	7.3	25	3.6	6, 8–10, 12	4.3	3.7
Chattahoochee River.								
Oakdale, Ga.	305	18	7.5	31	3.0	5, 6	5.3	4.5
West Point, Ga.	239	20	5.9	31	3.3	2–6, 9, 10	4.0	2.6
Eufaula, Ala.	90	40	12.5	31	1.7	9	5.9	10.8
Alaga, Ala.	30	25	10.8	22	5.2	9	6.0	5.6
Coosa River.								
Rome, Ga.	266	30	13.0	31	2.6	7–10	4.3	10.4
Gadsden, Ala.	162	22	11.1	31	3.2	10	5.5	7.9
Lock No. 4, Ala.	113	17	11.5	31	2.8	8, 10	4.6	8.7
Wetumpka, Ala.	12	45	20.5	31	6.4	10	9.8	14.1
Tallapoosa River.								
Milstead, Ala.	42	35	12.1	20	3.0	1–3, 6	4.9	9.1
Alabama River.								
Montgomery, Ala.	323	35	11.5	31	4.1	10	7.0	7.4
Selma, Ala.	246	35	13.2	1	5.1	10, 11	8.6	8.1
Black Warrior River.								
Tuscaloosa, Ala.	90	43	28.6	31	6.7	5	10.6	21.9
Tombigbee River.								
Columbus, Miss.	316	33	6.2	21	— 0.5	4–7	2.1	6.7
Vienna, Ala.	246	42	9.6	21	0.6	12–15	4.6	9.0
Demopolis, Ala.	168	35	15.5	14	2.9	7, 8	8.9	12.6
Leaf River.								
Hattiesburg, Miss.	60	20	5.5	31	3.2	7	4.0	2.3
Chickasawhay River.								
Enterprise, Miss.	144	18	11.0	31	1.6	4–7, 9	3.7	9.4
Shubuta, Miss.	106	25	8.5	21	2.6	7–15	4.4	5.9
Pascagoula River.								
Merrill, Miss.	78	20	7.4	17	2.4	5	4.5	5.0
Pearl River.								
Jackson, Miss.	242	20	8.5	17	2.3	8, 9	5.3	6.2
Columbia, Miss.	110	14	8.2	22	4.5	8, 9	5.8	3.7
Sabine River.								
Logansport, La.	315	25	22.6	23	4.5	15	12.9	18.1
Neches River.								
Rockland, Tex.	105	20	6.5	17	0.0	1–5	3.1	6.5
Beaumont, Tex.	18	10	1.7	16	0.8	10	1.2	0.9
Trinity River.								
Dallas, Tex.	320	25	8.9	18	4.2	29	5.3	4.7
Long Lake, Tex.	211	35	40.4	24	5.0	13, 14	19.9	35.4
Riverside, Tex.	112	40	24.9	31	1.7	15	10.7	23.2
Liberty, Tex.	20	25	21.1	31	4.7	1	10.5	16.4
Brazos River.								
Kopperl, Tex.	345	21	1.4	11, 14–16	0.2	4–9, 27–31	0.7	1.2
Waco, Tex.	285	24	7.5	15	3.2	8–11	4.1	4.3
Valley Junction, Tex.	215	40	7.9	16, 17	0.1	7, 8	1.4	7.8
Hempstead, Tex.	140	40	12.7	18	— 1.6	15	2.3	14.3
Booth, Tex.	61	39	3.8	18	2.2	1–14	2.8	1.6
Colorado River.								
Ballinger, Tex.	489	21	1.2	1–11	1.0	12–31	1.1	0.2
Austin, Tex.	214	18	2.9	17, 18	1.2	1–4, 7, 8	2.0	1.7
Columbus, Tex.	98	24	8.2	17, 22	6.2	31	7.2	2.0
Guadalupe River.								
Gonzales, Tex.	112	22	0.8	16, 17	0.3	1	0.5	0.5
Victoria, Tex.	53	16	1.8	19, 20	1.2	3	1.4	0.6
Red River of the North.								
Moorhead, Minn. (31)	284	26	.....	.....	.....	.....	.....	.....
Snake River.								
Lewiston, Idaho	144	24	6.0	28	1.2	1, 2	3.2	4.8
Riparia, Wash.	67	30	7.6	29	3.5	1, 5, 6, 9, 13	4.7	4.1
Columbia River.								
Wenatchee, Wash.	473	40	8.6	1, 2	6.0	31	7.2	2.6
Umatilla, Oreg.	270	25	6.0	23	3.6	19	4.5	2.4
The Dalles, Oreg.	166	40	9.0	24, 29	4.8	18, 20	6.3	4.2
Willamette River.								
Albany, Oreg.	118	20	10.0	21, 22	2.7	6	6.1	7.3
Salem, Oreg.	84	20	12.5	22	1.8	5	5.9	10.7
Portland, Oreg.	12	15	11.9	22	3.1	6	6.8	8.8
Sacramento River.								
Kennett, Cal.	259	23	10.7	27	0.0	1–7	3.1	10.7
Red Bluff, Cal.	201	23	17.5	27	0.6	1–7	4.2	16.9
Colusa, Cal.	157	25	25.2	28	3.3	2, 3	9.6	21.9
Knights Landing, Cal.	100	.....	16.3	30, 31	3.3	3–7	8.4	13.0
Sacramento, Cal.	64	25	20.5	27	7.3	1	12.5	13.2
Rio Vista, Cal.	26	12	6.4	31	2.8	24	4.7	3.6
San Joaquin River.								
Pollasky, Cal.	203	.....	3.0	26	— 0.3	1–3	0.5	3.3
Firebaugh, Cal.	148	.....	5.2	28	— 1.5	1–8	0.7	6.7
Lathrop, Cal.	49	15	12.8	14	1.1	3, 4	5.2	11.7

(a) One day missing. (b) Caused by ice jam. Figures indicate number of days frozen.

Honolulu, T. H., latitude 21° 19′ north, longitude 157° 52′ west; barometer above sea, 38 feet; gravity correction, —0.057 inch, applied. December, 1906.

Day.	Pressure.*		Air temperature.				Moisture.				Wind.				Precipitation.		Clouds.					
							8 a. m.		8 p. m.		8 a. m.		8 p. m.				8 a. m.			8 p. m.		
	8 a. m.	8 p. m.	8 a. m.	8 p. m.	Maximum.	Minimum.	Wet.	Relative humidity.	Wet.	Relative humidity.	Direction.	Velocity.	Direction.	Velocity.	8 a. m.	8 p. m.	Amount.	Kind.	Direction.	Amount.	Kind.	Direction.
1	29.89	29.89	72.0	71.0	78	67	67.5	79	68.0	86	e.	6	n.	5	0.01	0.00	1 few.	A.-s. Cu.	sw. e.	few.	S.-cu.	e.
2	29.91	29.92	73.5	70.0	78	66	67.5	74	67.0	86	n.	3	n.	2	0.00	0.00	few.	Cu.	0	few.	Cu.	e.
3	29.91	29.93	74.4	73.0	78	65	69.0	76	69.0	82	n.	4	ne.	3	0.00	0.00	few.	Cu.	0	0	0	0
4	29.91	29.87	75.0	77.0	78	70	71.0	82	73.0	83	e.	6	sw.	17	T.	0.60	8 2	A.-s. Cu.-n.	s. s.	10	S.	s.
5	29.90	29.93	76.0	76.5	79	71	71.5	80	73.0	84	s.	17	sw.	8	0.13	0.02	10	S.	sw.	5	S.	s.
6	29.98	29.97	75.0	75.5	81	70	72.0	86	71.0	80	ne.	3	s.	8	0.00	0.00	9 1	A.-s. Cu.	sw. e.	7	S.	e.
7	30.02	30.03	76.0	75.5	80	72	72.0	82	70.0	76	s.	4	ne.	10	0.00	0.00	8 2	A.-s. Cu.	0 e.	0	0	0
8	30.05	30.04	76.5	75.0	81	73	69.5	70	69.0	74	e.	6	ne.	8	0.00	0.00	3 7	A.-s. Cu.	0 e.	0	0	0
9	30.10	30.10	73.0	75.5	78	71	70.0	86	70.0	76	n.	2	e.	8	T.	T.	10	S.	0	8	S.	e.
10	30.09	30.09	76.4	74.0	80	70	69.3	70	69.0	78	e.	8	e.	12	0.13	0.04	7 2	A.-cu. Cu.	w. e.	10	S.	e.
11	30.08	30.03	75.0	73.0	80	71	68.0	70	68.0	78	e.	5	ne.	1	0.00	0.00	7 1	A.-s. Cu.	s. e.	0	0	0
12	29.98	29.94	75.5	76.0	79	71	70.0	76	74.0	91	se.	3	s.	20	0.00	0.02	3 3	Ci.-s. Cu.	s. e.	10	N.	se.
13	29.96	29.97	72.0	72.5	77	69	70.5	93	72.0	98	se.	15	n.	4	1.29	1.87	10	S.	sw.	10	S.	ne.
14	30.00	30.03	77.0	74.5	80	70	73.0	83	72.5	91	sw.	12	sw.	12	1.61	0.50	3 5	A.-s. S.	sw. sw.	2	Cu.	e.
15	30.07	30.05	74.0	73.0	78	71	69.0	78	68.5	80	ne.	12	ne.	14	0.02	0.00	few.	Cu.	e.	0	0	0
16	30.09	30.04	73.5	72.0	79	70	68.0	76	69.0	86	ne.	6	ne.	3	0.00	0.01	1	Cu.	e.	few.	N.	0
17	30.04	30.01	75.5	74.5	80	71	69.0	72	70.0	80	e.	13	e.	9	0.04	0.00	1	Cu.	e.	0	0	0
18	30.06	30.06	78.0	75.0	80	72	70.0	67	69.0	74	e.	4	e.	5	0.01	0.00	3	Cu.	e.	1	Cu.	e.
19	30.10	30.07	76.4	72.5	79	72	69.0	69	69.0	84	e.	7	ne.	8	0.00	0.03	3	Cu.	e.	7	N.	e.
20	30.11	30.03	72.5	73.0	75	69	66.0	71	69.0	82	e.	11	e.	10	0.05	0.06	8	Cu.	e.	8	N.	e.
21	30.03	30.03	66.5	68.0	72	64	66.0	97	64.0	80	e.	18	sw.	10	0.47	0.50	10	N.	ne.	6 3	S. N.	e. e.
22	30.02	30.08	69.0	68.0	71	63	63.0	72	65.0	85	ne.	24	ne.	6	T.	0.14	2 2	A.-s. Cu.	0 e.	3	Cu.	e.
23	30.09	30.11	70.5	71.0	73	64	63.0	66	67.0	81	n .	22	ne.	18	0.06	0.00	1	Cu.	e.	8	Cu.	e.
24	30.14	30.10	71.5	71.0	73	63	62.0	58	66.0	77	n .	24	e.	21	0.05	0.02	7	Cu.	e.	9 1	A.-s. Cu.	ne. e.
25	30.12	30.07	71.0	70.0	73	64	62.4	62	64.0	72	ne.	22	e.	15	T.	T.	5 4	A.-s. Cu.	0 e.	10	N.	e.
26	30.04	30.00	70.0	71.0	76	65	64.0	72	64.0	68	e.	12	e.	8	0.18	T.	3 1	Cu. N.	e. e.	6	Cu.	e.
27	29.97	29.94	72.0	71.0	78	65	66.0	73	66.5	79	ne.	4	e.	12	T.	0.03	2 2	Ci.-s. Cu.	sw. e.	5 1	Cu. N.	e. e.
28	29.91	29.84	73.0	72.0	76	68	66.0	69	66.0	73	e.	2	ne.	8	0.25	T.	1	Cu.	e.	6 1	Cu. Cu.-n.	e. e.
29	29.75	29.56	72.5	72.5	76	64	67.0	75	68.0	80	e.	3	se.	16	0.01	T.	2	S.-cu.	sw.	8	S.	se.
30	29.51	29.58	61.0	72.0	72	59	59.0	89	69.0	86	ne.	5	s.	20	1.56	0.01	10	N.	e.	10	S.	e.
31	29.72	29.78	73.5	74.0	76	67	67.5	74	69.0	78	se.	20	se.	32	0.12	0.18	4	S.-cu.	s.	8	Cu.	se.
Mean	29.985	29.971	73.2	72.9	77.2	68.0	67.7	75.7	68.7	80.9	e.	9.8	ne.	10.7	5.99	4.03	5.6	Cu.	e.	5.3	Cu.	e.

Observations are made at 8 a. m. and 8 p. m., local standard time, which is that of 157° 30′ west, and is 5h and 30m slower than 75th meridian time. * Pressure values are reduced to sea level and standard gravity.